

No 29

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MODEL ENGINEERS'

WORKSHOP

THE PRACTICAL HOBBY MAGAZINE



INTERNAL SLOTTING ATTACHMENT

To fit a Mill/Drill

DRAWBAR EXPONENT EXTRAORDINAIRE

Jim Canner explains his methods

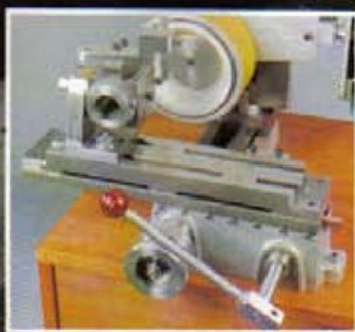


A BRACE OF FLYCUTTERS

*One with an
adaptable shank*

JOINING ALUMINIUM

*Hard and soft
soldering
methods
exchanged*



TOOLS AND TOOLING

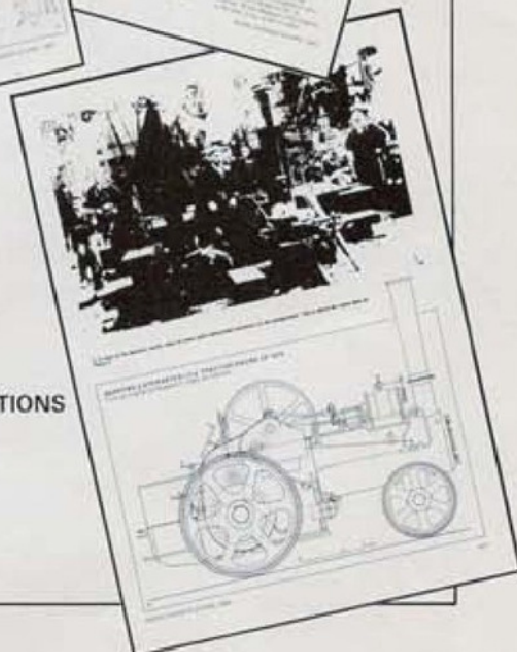
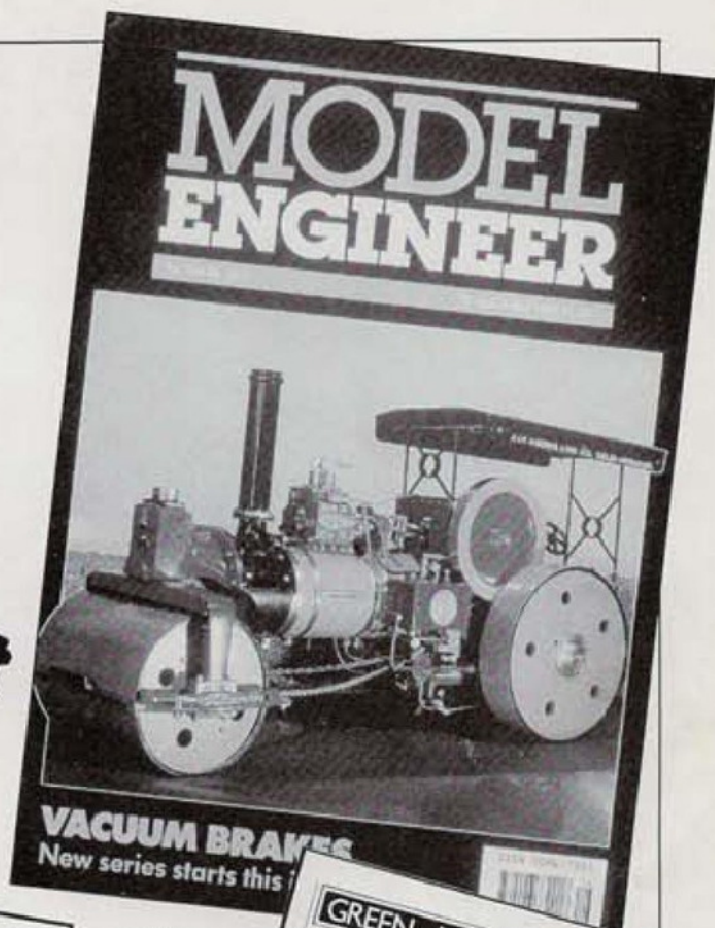
At the 64th M.E. Exhibition



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NEXUS

**SOMETHING
TO LOOK
FORWARD
TO...**
...every fortnight

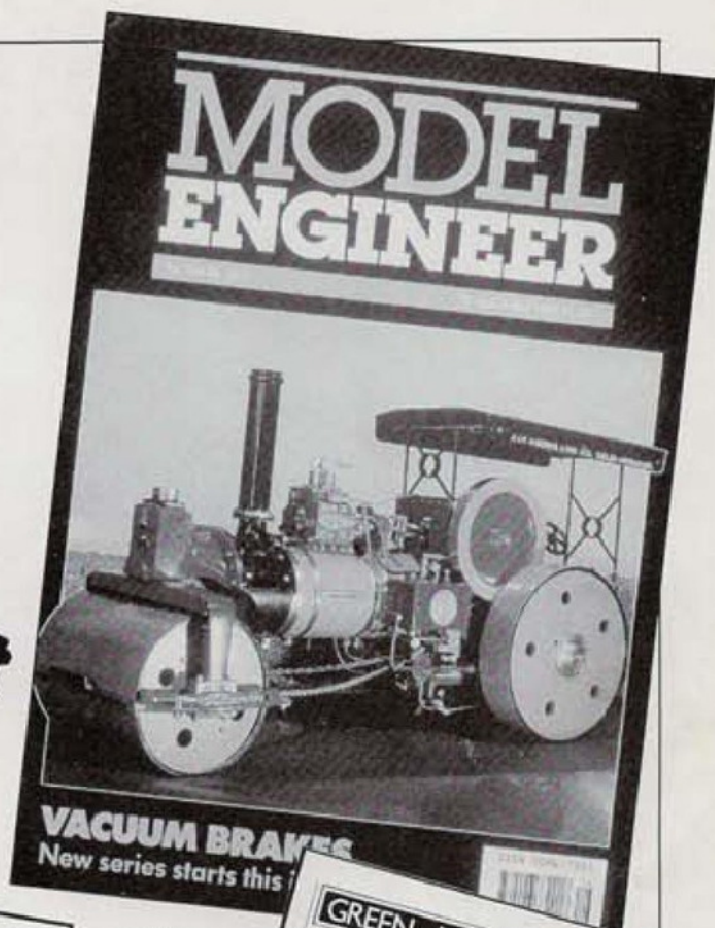


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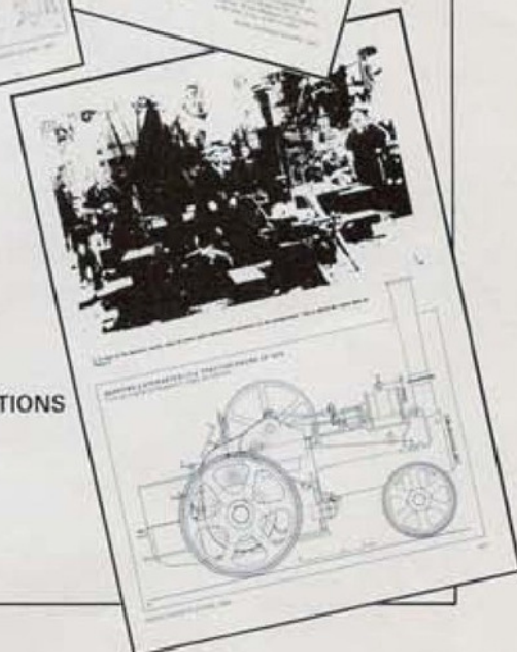
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Geoff Sheppard

ON THE EDITOR'S BENCH

It is with a great feeling of anticipation and no little trepidation that I write my first Editorial. *Model Engineers' Workshop* has, from its earliest days been one of my favourite magazines. Put together initially out of an inspired idea by my old friend Stan Bray, it has been developed to a very high standard by my new friend Harold Hall. I am very much aware that I have a hard act to follow. Much of the mail I have received in these early days has contained appreciative comments for the work that Harold has done. I echo these sentiments and wish him all the best for the future. He is not going to get away that easily, though, as you will see from the contents of this issue.

Who is Geoff Sheppard?

Harold kindly gave me a brief introduction in Issue 28, but I believe that you will wish to know a little more about the person who is moving in to his editorial chair. I think it is true to say that I am an engineer by natural inclination, as well as by profession. If there are such things as hereditary influences, then these must have come from my maternal grandfather, who was a fine engineer, craftsman and inventor. He worked mainly in sheet metal and family folklore has it that he invented a now familiar piece of domestic equipment, but not being interested commercially, left someone else to patent it and to exploit it. Unfortunately, he died before I was old enough to appreciate the nature of his talents.

It was almost without debate that I entered the aero-engine industry, being fortunate enough to obtain an Aeronautical Engineering Apprenticeship with the then Aero-Engine Division of the Bristol Aeroplane Company. This training was intended to qualify one to a standard at which entry to one of the professional institutions could be obtained and I duly completed the apprenticeship and specialised as a Mechanical Development Engineer, working on gas turbines. Career progression took me through a variety of technical and management posts, both in the mainstream and in a number of support roles. The search for solutions to a number of problems with the Proteus engines of that beautiful machine, the Bristol Britannia airliner, involved me in the use of the then new-fangled devices called computers in the manipulation of massive quantities of data - a branch of the science now known as Information Technology. I therefore lost my fear of the beasts many years ago. My final years in the industry were spent as an Engineering Quality Assurance Manager in the Design and Development environment, until after 41 years in the business, I decided that there

were still more things to do and that my workshop was calling. However, within a matter of days, the telephone rang.....!

My model engineering career started, as did that of many a small boy, when enlightened parents gave me a huge Meccano set at Christmas. A progression to aeromodelling brought me in contact with my first i.c. engine, that classic, the Mills 1.3 cc diesel. Then, one winter's evening in the late 1940s a neighbour invited three members of the local 'gang' to a meeting of a club of which he was a member. Into town in his car, where we groped our way across a dimly lit car park to where a door opened occasionally to emit a shaft of yellow light. Once inside I was met with a spectacle I shall never forget. We were stood on a platform near the ceiling of a square basement room. A wooden staircase clung precariously to two walls as it wound down to floor level. A single, large bulb hung from its flex to illuminate the scene below. A group of men stood around the walls, facing inwards and concentrating hard on the activity in the centre. Clouds of acrid smoke curled up from below, making our eyes sting. And the noise! We were at a meeting of the Bristol and West Model Car Club at their indoor track in St. Agnes Church Hall. The cars, of course were of the tethered variety, and I was hooked! With an out-dated car, courtesy of the neighbour, I was able to learn the business, mainly on the outdoor track in one of the suburbs.

The neighbour was also a member of the Bristol Society of Model and Experimental Engineers, so I was soon enrolled there as well, where I enjoyed the activities at the old Canford Park railway track.

There was a lull in proceedings while exams were passed and a career established, but in the 1960's I joined the committee, soon becoming Vice-Chairman for three years, then Chairman for a similar period. It was during this time that we built our new railway at Ashton Court.

My workshop was built up over many years, starting with a 3 inch Zytol lathe, purchased as many others have been, from the estate of a deceased club member. As others became available this was replaced by, in turn, a Portass, a Granville and then with a stroke of luck in the Society's fund raising '100 Club', a Myford Super 7. Most small tools were purchased at Society Bring and Buy nights, and like Harold, I also built one of the drilling machines from castings by E.W.Cowells of Watford (but mine is painted - in fact the paint is now coming off, so if you would like to do two at once, Harold). A hand shaper from the same stable, bandsaw, belt finisher, and a locally made Portmac vertical milling machine now populate the workshop, with a brazing hearth down in the garage.

Unfinished projects lie thickly about the place, but I have built quite a few marine and stationary boilers in my time, including the one for the S.S. Great Britain model with which my friend Will Mowll won a Gold Medal at the M.E. Exhibition a few years back. For some time now I've been doing the same job for the HMS Warrior model he is building, and hopefully that 'pot' (coal fired this time) will be complete before you read these words.

I have many other interests, including as Harold mentioned, the restoration of vintage vehicles and an involvement on the technical side of motor sport, but some of these will have to take a back seat for a little while, as I come to grips with this job.

Future policy

Where do I intend to take the magazine from here? Well, as far as I am concerned, it's going to be very much business as usual. As I mentioned above, your letters and the recent Reader Survey indicate that you like things pretty much the way they are and that your preferences for the future are very much in line with my own thoughts. Topics which head the list are: small item construction, large item construction and processes, so I will try to make sure that there are plenty of those. This does not mean that minority interests will not be catered for because we must keep a balanced content and let's face it, peoples preferences do change. As some of you will probably know, every year, in early May, I join Stan Bray to run the model engineering workshop at the Modellers' holiday at Primrose Valley at Filey in Yorkshire. It is customary on the Monday evening for us to run a forum to discuss topics of mutual interest. Last year we challenged the assembled company to tell us where they thought that the hobby was heading and what their future interests were likely to be. A shock to some, but not at all surprising to me, was the general consensus that model locomotives were now old hat and that traction engines were beginning to become a bit of a bore. Good quality marine and stationary engine designs, internal combustion engines and tools are beginning to see a revival of interest. These views were borne out in part by the entries at this years International Model Engineer and Modelling Exhibition held at Olympia. The future promises to be interesting.

One final thought, I have just realised that I shall no longer have the pleasurable anticipation of waiting for *Model Engineers' Workshop* to drop through the letter box - I shall know the content already!

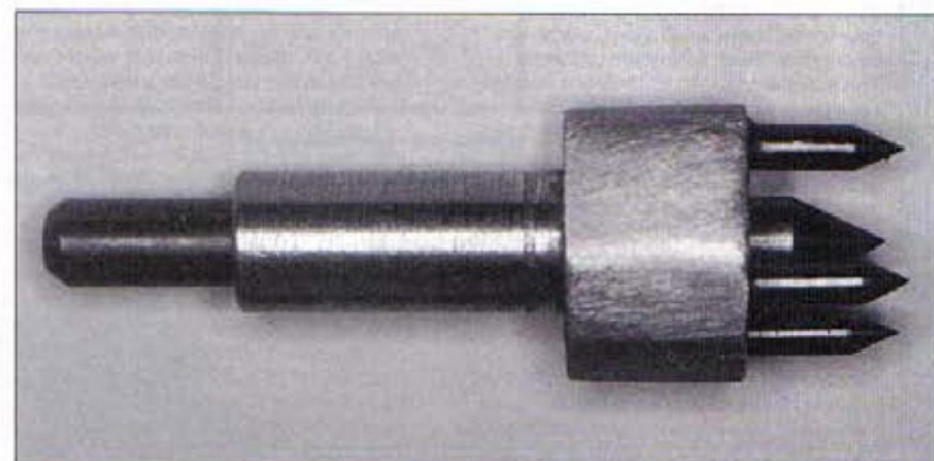
A CENTRE PUNCH GUIDE

Accurate marking out provides a firm foundation for many of the jobs we carry out in the workshop. Bob Loader describes a neat tool which will soon repay the couple of hours spent making it by getting those centre pops where you really want them.

There are many ways of putting holes in the right place. The best ones need a milling machine, especially one with an accurate lead screw. I remember once getting caught, or almost caught, by one which had a variation of 0.002 in. over 1½ in. of the most used piece of the table. Luckily, I'd done a sample and had it checked by the inspection department, so I could allow for it. Most milling machines which have seen a bit of service will have slight errors and some of us don't have milling machines, so for those who are limited to the old fashioned centre punch - centre drill - and hope it is in the right place - school, here is a gadget which is easy to make and use and will help to make sure that the centre punch is in the middle of marked lines.

Essentially, it puts the centre punch over the intersection of two scribed lines. **Figs. 1 and 2** show the assembly and the body of the guide. Once it has been positioned, the punch is slid into the central hole, tapped to make a mark, then deepened by another punch if needed. The guiding is done by the three points shown at Item 3 of Fig. 1. Two of the points are in line with the central hole, the third at right angles to the in-line ones. The technique is to locate the two in-line points in one scribed line, draw the guide towards the other scribed line with the third point trailing across the surface of the work until it drops into the line. When it does, the central hole is over the intersection. The punch is then slid into the hole and tapped. If the mark is deep enough, it can be left. If it needs to be deeper, a larger punch can be used.

Making the guide is a fairly easy job and the only tricky bits are the points which do the locating. The point has to be truly in the centre of the diameter, so if you have collets, use them. If you are limited to a three jaw chuck, make sure that the work is



spinning as true as possible. Hold a pencil against a solid part of the machine and gently touch the revolving work; you will soon see if it is running true or not. If it isn't, try holding it in slightly different positions. If that doesn't work, try shimming one of the jaws with a piece of cooking foil. It is possible to get even a dodgy chuck to hold true if you fiddle about a bit.

The tool for turning the points must be exactly on centre. If it isn't there will be a flat in the middle or a not very good point. A 30 degree, included angle will be strong enough to do what it has to do without being fragile. **Fig. 3.** shows the points and the punch.

A refinement is to make the three points with knife edges. This would make the operation of the guide much easier, but the making would be more difficult. The knife edges would have to be exactly on the centre line of the diameter and it would be a bit of a job to set two in line and the third at right angles.

Another possibility I considered was to insert needle points into the ends of the points. With this in mind, I measured a selection of my wife's sewing needles. In a range from 0.024 in. to 0.047 in. there were 5 sizes and it would be possible to find drills somewhere between No. 74 and No. 56 to give the right fit. I found by trying them, that needle points drop nicely into scribed lines; even quite large ones are sharp enough. The same thing applies about the accuracy of the points with respect to the centre lines - it must be right.

Making the punch which goes with the guide is very simple. If the dimensions chosen for the large hole in the guide are

the same as mine, a piece of 6mm. diameter silver steel 70 mm long or thereabouts will do nicely. Both the points and the punch will need hardening before the guide is assembled. For both the points and the punch, just the first 5 or 6 mm of their length will be hard; temper them to brown.

The body of the guide is straightforward turning and a little filing. It doesn't have to be the shape I've drawn, as long as the holes are in roughly the same position. It could be a round shape, 20 mm diameter, without fancy flats. The important things are the alignment of the holes for the points with the central reamed hole for the punch to slide in, and the third hole on the same centre line as the central one.

The reamed hole for the punch must allow it to slide, but only just. If a standard reamer is used with stock silver steel of the same diameter, it will give just those conditions. Reaming the holes for the points is different. The reamer must not be taken right through. Experiment with a piece of scrap mild steel to find out how far to ream so that the points will press in tight and leave enough sticking out to do the job. Between 12 and 15 mm is about right. Any less and it will be difficult to see to position the points in the lines.

The guide works well as long as the marking out can be scribed nice and deeply. If the work being done needs a good finish and the lines cleaned off afterwards, forget it and choose another method, but for jobs where it doesn't matter, or the lines will be hidden, it is a good way of putting the holes where they should be, with a reasonable degree of accuracy.



KEYS & KEYWAYS

Whether it is a feature of one of our workshop projects or an integral part of a machine tool, the keyed drive is a fundamental item of mechanical engineering technology. In this comprehensive review, Alan Jeeves surveys the systems available and gives us some tips as to how to produce them in our home workshops



A traction engine flywheel keyed to the crankshaft

In order to arrange a drive between a shaft and a hub in relation to each other, some sort of key system is required to transmit the movement of the revolving shaft to the hub (or vice versa). If a drive key is not provided, the shaft is able to spin in the bore of the hub, delivering no transmission at all between the two. Keys take many forms and it is worthwhile the amateur engineer looking at a few in order that he may be able to select a suitable system for the type of project he is currently working on.

Often a pulley is offered to a shaft and is simply driven by a grub screw which is appointed at a right angle to the bore and is firmly tightened down onto the shaft. An improvement upon this method is to 'dimple' the shaft thereby allowing the grub screw to enter the indentation and thus assist in preventing the pulley from

spinning on the shaft. Sometimes a small flat is provided on the shaft instead. These methods are fine if all that is needed is a light drive, but when a positive drive is called for where there has to be absolutely no chance of the shaft slipping in the hub, a key is incorporated into the design and this key will be carefully selected from a wide range which is at the disposal of the engineer.

Keys go back almost to the very invention of the wheel. A pair of wheels on an axle may be

"Roebuck" Combined Slotting and Shaping Machine

FIG. 4075

Illustration No. 1 shows the apparatus as a bench shaper. Maximum Stroke 7 1/2 in. Automatic Traverse, 10 in. Width keyway at interpolation, 1 in.

Illustration No. 2 shows the same used as a slotting machine.

The Standard supports the shaper in a vertical position over the bed plate.

It is arranged that the height of the Machine above the bed plate can be varied, while in the case of a large piece of work the machine can be attached to it direct.

No. 1

Combined Shaping and Slotting Machine, complete with Bed plate and Upright Angle Bracket and Tools

Shaping Machine only, with Bed plate and Gripping Plates, as illustration No. 1

Slotting Machine only, with Upright Angle Bracket and Bed plate, as illustration No. 2

If without Bed plate

Slotting Tool Box only

Bed plate and Gripping Plates

Angle Bracket only (for slotting)

PRICES on application

No. 2

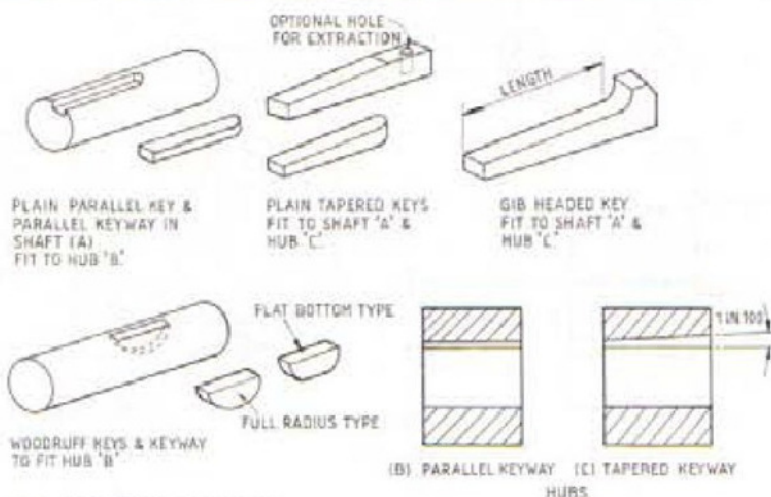


FIG. 1 COMMON KEYS & KEYWAYS

allowed to spin freely if they are used only as an aid to transporting an object, the driving energy being applied to the actual object (pushing or pulling), but when the wheel itself is required to drive a shaft, as in the treadmill, no wasted energy could be spared by the slipping of wedges and probably the earliest form of positive key was a pin through the centre of the hub and axle (which we now call a cotter). As long as the pin remained in place and did not shear, the wheel would drive the axle. By drilling a cross hole through the axle though, the axle was markedly weakened. Early axles (being, of course, made of wood) were square in section and would readily transmit power.

Steam Engines To The Fore

With the coming of the practical steam engine in the 18th century, the world of engineering was about to

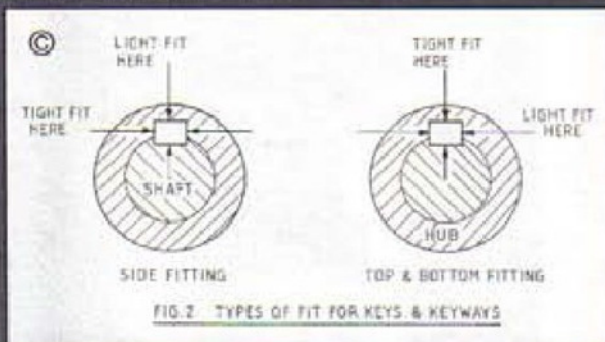


FIG. 2 TYPES OF FIT FOR KEYS & KEYWAYS

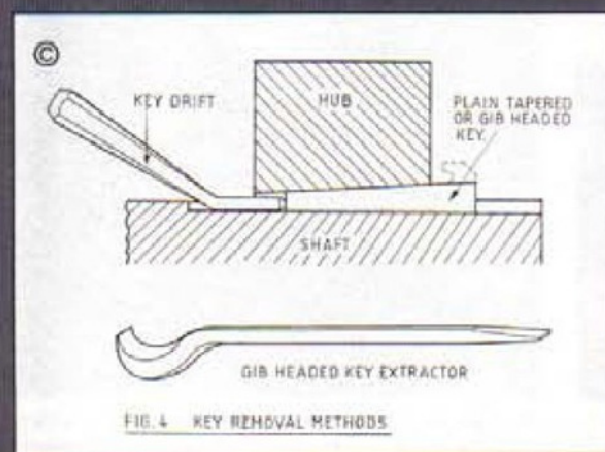


FIG. 4 KEY REMOVAL METHODS

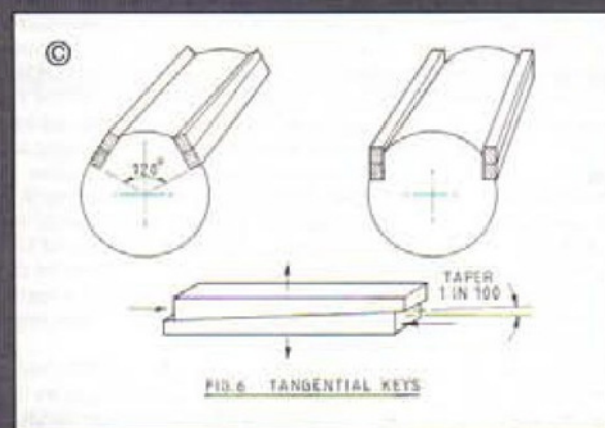


FIG. 6 TANGENTIAL KEYS

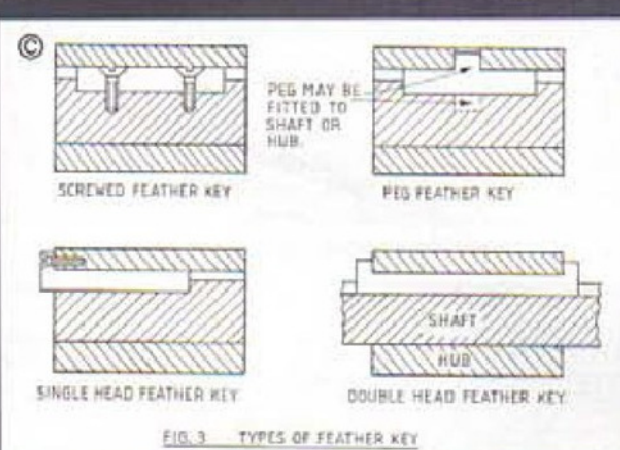


FIG. 3 TYPES OF FEATHER KEY

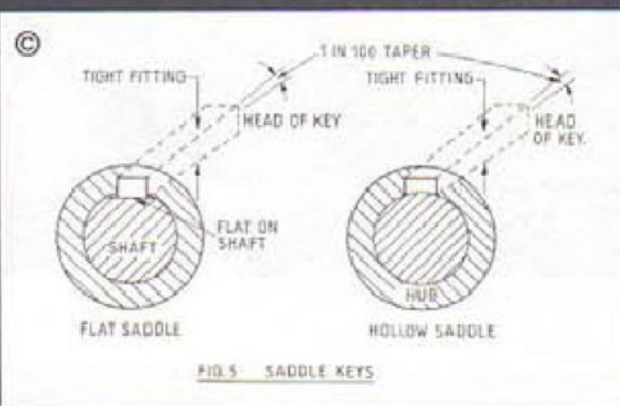


FIG. 5 SADDLE KEYS

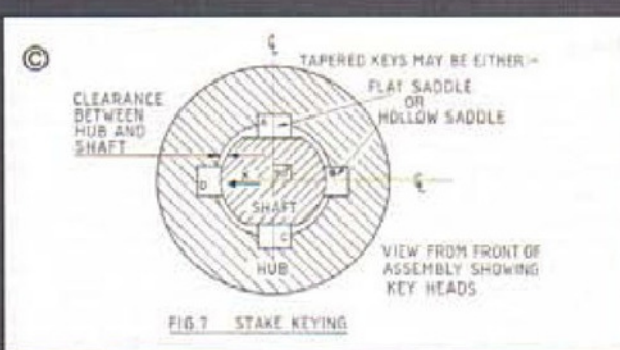


FIG. 7 STAKE KEYING

change dramatically. Men like Newcomen made advances in the early 1700's, Cugnot had built his steam carriage in 1763, and in 1801 William Symington had built the first steam boat, the Charlotte Dundas, using an engine constructed by James Watt. 1813 saw William Hedley's locomotive Puffing Billy on the rails and later Stephenson's famous locomotives were to become world leaders. In 1920 in America a 400 ton railway locomotive hauled a train consisting of a further 15,400 tons for a distance of 125 miles and locomotives throughout the world regularly exceeded 100 mph. Wood was no longer used as a major engineering material and square axles and shafts made out of metal were not a practical proposition. All the work was going to have to be done by the key, which led to the successful development and use of this simple but essential part of mechanical engineering and by 1929 the

British Standards Institute had published a standard on keys and keyways in BS. 46.

Plain Parallel Keys

Plain parallel keys are perhaps the most common keys encountered by the model engineer. In their simplest form they are but a piece of square or rectangular steel which is fitted halfway into a shaft and half way into a hub. These are known as 'sunk keys' (Fig. 1). Where a short keyway is machined away from the end of a shaft it usually has radiused ends and the parallel key is also radiused to suit. A guideline for the dimensions of these keys prior to the compilation of standards was that the width of the key should be equal to $\frac{1}{4}$ of the diameter of the shaft, the thickness of the key should be $\frac{1}{4}$ of the diameter of the shaft and the minimum length of the key

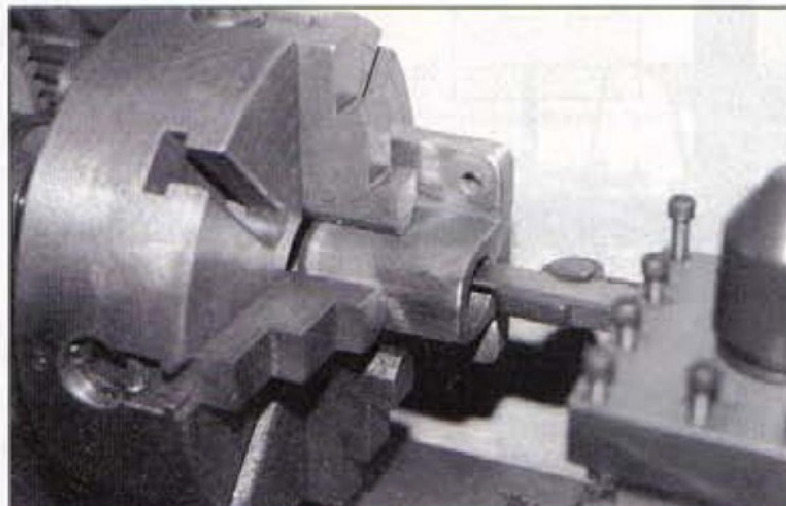
should be $1\frac{1}{2}$ times the diameter of the shaft. However, BS. 46 and also BS. 4235 (metric keys & keyways), give details of the standard key which you would expect to find for a given shaft diameter. The tables outline sizes which may be useful to model engineers.

Parallel keys are normally used for applications where low starting torques are encountered and may be used also for unidirectional torques. When fitting these keys, they are located by a method known as 'side fitting'. This means that the key bears tightly on the sides and has clearance at the top (Fig. 2). It is also usual to let the key bear more heavily in the shaft keyway than in the keyway of the hub. This allows the hub to slide off more readily (leaving the key remaining on the shaft) when dismantling.

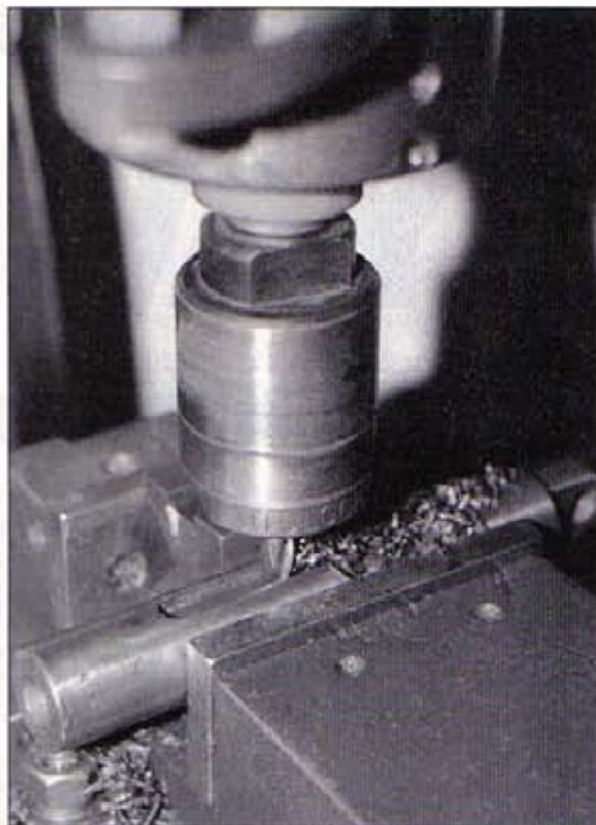
Occasionally a parallel key is secured in position so that it is unable to move laterally in the keyway. This may be done



A long keyway (drilled) and a feather key



Slotting a mandrel guide in the lathe



Cutting a keyway in the mill/drill

by means of screws, pins or raised heads on the key. These particular keys are known as 'feather keys' (Fig.3).

Taper Keys

Plain taper keys are parallel in width, but are tapered over the thickness from front to rear. The taper is machined on the top of the key and is a taper of 1:100 (0deg.-34min.-23sec.) as standard. They are used in applications where heavy, vibrating loads are transmitted and are especially useful where the shaft is constantly reversing in direction.

When fitting these keys, there is no clearance at the top, as there is on side fitting keys, but they are an easy fit on the

sides. This method is called 'top and bottom fitting' (Fig.2) and it makes for a very soundly located key. When machining the shaft keyway to accept these keys, it is normally extended some distance from the back of the hub, which allows it to be drifted out at a later stage when dismantling is necessary (Fig.4). Sometimes these keys are made a little larger at the head and a hole is drilled through to assist extraction (Fig.1).

In addition to the plain taper key, another two types of key exist which require accurate fitting and are suitable for light drives only. The first of these is the 'flat saddle key', where a flat is provided on the shaft and a keyway is machined in the hub (Fig.5). As an alternative, no work is done to the shaft at all and the key is provided with a radius on the base which is equal to the radius of the shaft. Again, a tapered keyway is machined in the hub. This second key is known as the 'hollow saddle key' (Fig.5).

A key which is frequently seen is the 'gib headed key'. This is a tapered key with a protrusion at the head which is there to

facilitate the removal of the key. These keys are fitted using the top and bottom method and work similarly to the plain taper key. On applications where it is difficult to get behind the tail of the key in order to drift it out, the gib headed key can be levered out from the front using a special lever wrench as an extractor (Fig.4). If the gib head is too close to the hub to get the hook of the extractor behind it, the wedge shaped opposite end is utilised to prize it out sufficiently to clear the hook. A typical example of where this key can be seen is on the traction engine flywheel.

A type of taper key which the model engineer will seldom encounter, as its use is mainly on large shafts (over 150mm for single directional torques and over 100mm for unidirectional torques), is the 'tangential key' (Fig.6) where twin keys are fitted in the same keyway. This method of keying acts like a wedge, the two tapered (1 in 100) keys being tapered further in to tighten them. Another similar system is called 'stake keying' and keys are normally used in sets of 4 (Fig.7). They may be either flat or hollow saddle keys and must be accurately fitted to centralise the hub as it is oversize on the shaft. This method allows an oversize hub to be fitted onto a smaller diameter shaft without resorting to bushing. Referring to Fig. 7, if key 'B' is tapped further in to the assembly and key 'D' is tapped further out of the assembly, then the shaft will move in the direction of arrow 'X'.

Woodruff Keys

A very useful key and keyway for modelling work though, is the Woodruff key which may be utilised for light duty

DATA BOOK ERROR

Lightning strikes twice!!

In Issue 28 (Page 65) we noted that an error exists on Page G1 of the *Data Book* and gave a revised formula. Unfortunately, somewhere along the process to final printing, a further error crept in. Therefore, here is another attempt to get it right.

The formula for height

H should read:-

$$\text{Height } H = D/2 - 1/2 \sqrt{D^2 - C^2}$$

As we said before, the correction will ultimately be published in the *Data Book*.

QUICK TIP

Using epoxy or polyester resin (1)

Methylated spirits is a useful solvent for cleaning off surplus resin before it sets. Have some to hand before starting work.

W J R H Pooler

work (Fig. 1). This particular key takes the form of a segment of a circle with parallel sides. A keyway is cut into the shaft which matches the radius of the key and a conventional parallel (to the bore) keyway is machined into the hub. Woodruff keys are designated by a number system in which the final two digits reveal the nominal diameter of the key in $\frac{1}{32}$ ths of an inch and the number or numbers before the final two reveal the width of the key in $\frac{1}{32}$ nds of an inch.

Thus: No. 304 = $4 \times \frac{1}{32}$ ths = $\frac{1}{8}$ in. nom. dia. $\times (3 \times \frac{1}{32}$ nds) = $\frac{3}{32}$ in. wide.

Woodruff key cutters are properly identified by the same system as the key but are sometimes referred to using the diameter $\times$ the width or (up to about 1960) the numbering system in Table 4. Consequently, some old cutters which turn up from time to time may be marked with these numbers and the table may help to identify them. In addition to these, some Woodruff cutters are manufactured with metric dimensions. These cutters, as yet, have not become popular with amateurs in this country and a table of these is also included (Table 5).

The Woodruff key is not an exact semi-circle, but slightly short of one. Two types of Woodruff key are generally used - the familiar 'full radius' type and the 'flat bottom' type (Fig. 1). These keys are especially useful for keying hubs onto tapered shafts, as restorers of classic motorcycles will testify. The flywheel magnetos were often secured to the crankshaft by this method, their main function being to prevent the flywheel from

slipping or being located at the wrong 'o'clock' (which could play havoc with the timing of the ignition), the taper on the shaft and hub forming the main (friction) drive.

Other Types Of Key

Sometimes, although very rarely nowadays, 'dovetail keys' are used. These are keys which have one part of their cross section shaped as a dovetail - the narrower face being the bottom of the key and so fits the shaft. Another extremely useful and simply formed key is the 'round key'. This key is just a round dowel which fits into a drilled hole, half into the hub and half into the shaft (Fig. 8). This is probably the easiest key system to produce in the home workshop. A variation of this key is where the hole is drilled and tapped and a screw is fitted as the key. Quite a good drive can be obtained in this way and, of course, more than one screw may be fitted. It is beneficial to note that where hubs are to be heat treated after a keyway has been cut, it may be an advantage to form the keyway with substantial radii at the corners (Fig. 16), in order to prevent cracking at these points. The key has to be radiused at the corners to match this type of keywaying. The round key, therefore, is a very good keyway to employ for heat treated hubs.

Cotters are a form of key and are used when two shafts need to be connected together and may be subjected to compression or tension. A high shear strength is not normally possible with

cotters as a means of driving. They may be of several different shapes in cross section, a rectangular wedge shape being very popular at one time, but most are commonly found to be round. They may be parallel or tapered and taper cotters have a taper of between $\frac{1}{4}$ and $\frac{1}{2}$ in. per foot. (Standard taper pins taper at $\frac{1}{16}$ in. per foot). Sometimes a screw is used to hold the taper cotter in place and in this event a steeper taper may be used. It can be increased to $1\frac{1}{2}$ to $2\frac{1}{2}$ in. per foot under these circumstances. Table 6 describes the method of designing rectangular cotters for use with square or round bars.

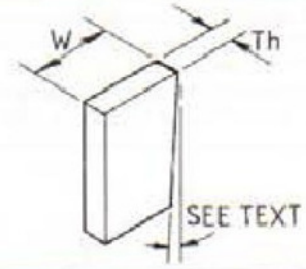


Table 6
PROPORTIONS OF RECTANGULAR COTTERS THROUGH BARS

THROUGH ROUND BARS	THROUGH SQUARE BARS
$W = 1.464 \times \text{dia}$ $Th = \text{dia.} / 5$	$W = 1.5 \times \text{side of bar}$ $Th = \text{side of bar} / 4$

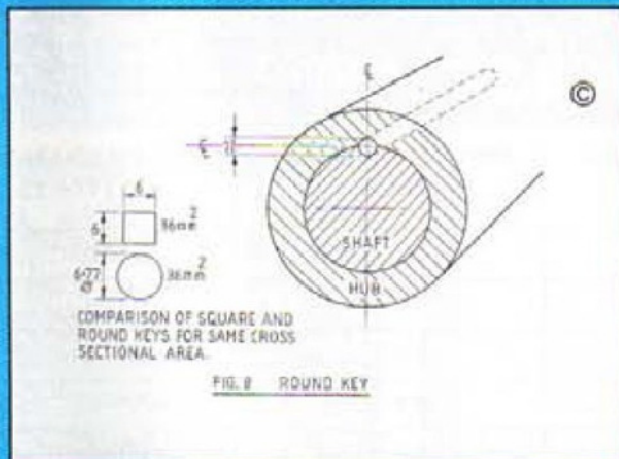


FIG. 8 ROUND KEY

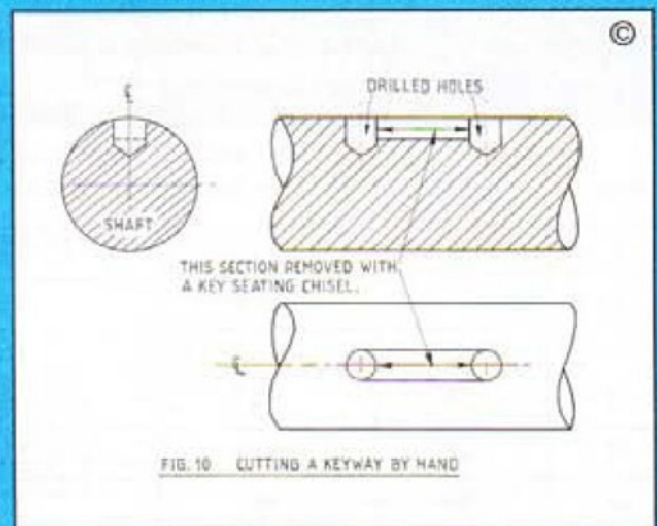


FIG. 10 CUTTING A KEYWAY BY HAND

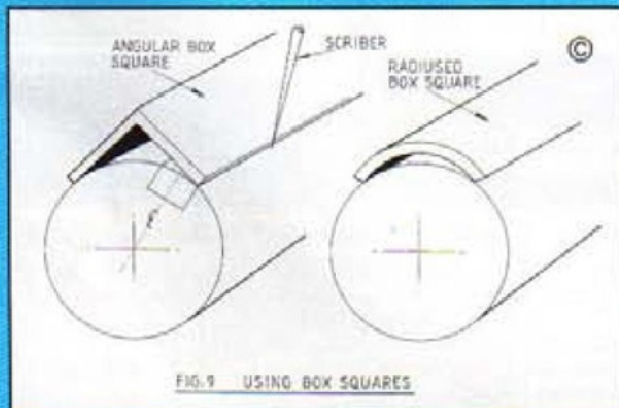


FIG. 9 USING BOX SQUARES

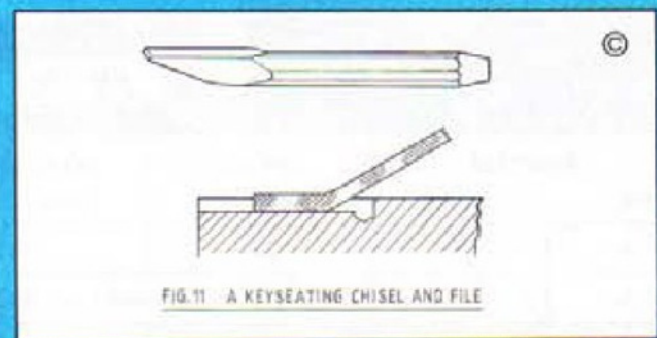
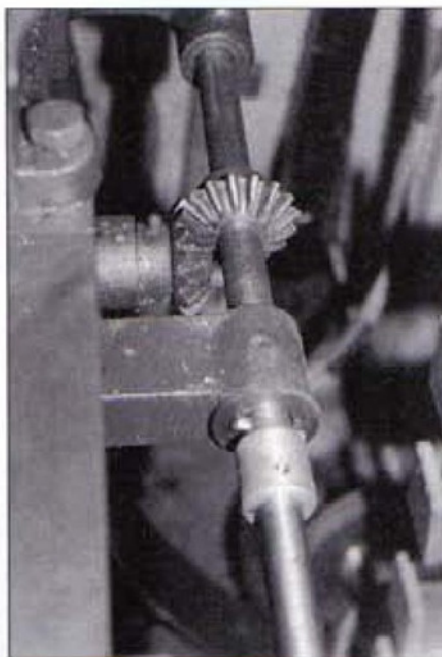
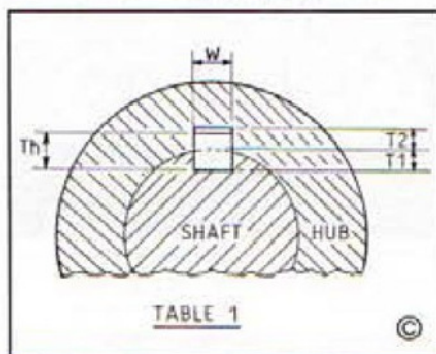


FIG. 11 A KEYSEATING CHISEL AND FILE

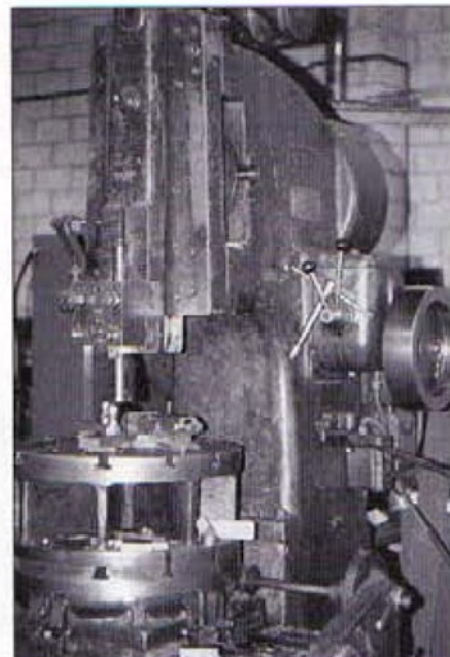
Key Steel

A term often heard in the engineering sphere is 'key steel'. This is a reference to the material supplied in lengths of square or rectangular section which dimensionally correspond to standard key sizes. A better term to use for steel supplied in this way is 'key bar' or 'key stock', as key steel implies that it is a special steel reserved exclusively for the making of keys. This is not so. BS. 4235 (keys & keyways) calls for keys to be of a tensile strength of not less than 550 MN/sq.M in their finished condition and that they may be made from steels selected from BS. 970 (unless special materials are specified e.g. stainless steel). Therefore the correct steel for the model engineer to select for the majority of his keys will be 070M20. This is a plain carbon steel containing 0.7% manganese and 0.2% carbon. This material will comply with the minimum tensile strength requirements of BS. 4235 when making keys up to and



Bevel gears driven by taper pins

including 25mm x 14mm in cross section. For keys exceeding these dimensions the steel to use would be 070M26 which has a slightly higher carbon content (0.26%) and is suitable for keys over 25mm x 14mm up to and including 36mm x 20mm in cross section. Other steels are used for larger keys than these but will not normally concern amateur engineers. As keys



A 10 in. slotting machine.

become larger the manganese and carbon content increase. For those who still like to work in the good old 'English System' most of your keys will be made out of EN 3, which has a tensile strength of 28 tons/sq.in. Generally speaking the shear strength of a material can be found by multiplying the tensile strength (either metric or imperial) by 0.8.

TABLE 1a
RECOMMENDED METRIC PARALLEL KEYS & KEYWAYS
FOR MODEL ENGINEERS

SHAFT DIA OVER	UP TO	KEY SIZE W x TH	DEPTH OF KEYWAY INTO SHAFT T1	DEPTH OF KEYWAY INTO HUB T2	STANDARD TOLERANCE FOR T1 OR T2
6	8	2 x 2	1.2	1	+ 0.1 - 0
8	10	3 x 3	1.8	1.4	+ 0.1 - 0
10	12	4 x 4	2.5	1.8	+ 0.1 - 0
12	17	5 x 5	3	2.3	+ 0.1 - 0
17	22	6 x 6	3.5	2.8	+ 0.1 - 0
22	30	8 x 7	4	3.3	+ 0.2 - 0

TABLE 1b
RECOMMENDED IMPERIAL PARALLEL KEYS & KEYWAYS
FOR MODEL ENGINEERS

SHAFT DIA OVER	UP TO	KEY SIZE W x TH	DEPTH OF KEYWAY INTO SHAFT T1	DEPTH OF KEYWAY INTO HUB T2	STANDARD TOLERANCE FOR T1 OR T2
1/4	1/2	1/8 x 1/8	0.072	0.060	+ 0.006 - 0
1/2	3/4	3/16 x 3/16	0.107	0.088	
3/4	1	1/4 x 1/4	0.142	0.115	
1	1 1/4	5/16 x 5/16	0.177	0.142	

Cutting Keyways

There are several techniques for the cutting of keyways dependent upon the equipment available and it is safe to say that, in the amateur's workshop it may be limited, and certainly equipment will vary widely from shop to shop. The most unlikely machine to be found in the amateur environment will be a slotting machine, although attachments for milling machines and lathes are becoming more widespread in home workshops now. Model engineers of a generation past could purchase a small hand operated slotting machine (or shaping machine), but these seem to have lost favour. Anyone having the opportunity of acquiring such a machine would be indeed fortunate. Keyways can be produced on lathes, milling machines, slotting machines, shaping machines and presses. In addition to all this hardware, keyways can also be cut by hand. If you are short on equipment, but are prepared to put in a bit of time, some very acceptable work can be turned out. Maintenance fitters in industry regularly used hand tools for 'in-situ' work (before the introduction of portable, self powered keyway cutting equipment which clamps onto the shaft), back in the days when keyways were commonly known as 'key seats'.

Hand Cut Keyways

The keyway is carefully marked out prior to the actual removal of any metal and this can be done by one any one of many methods available which the craftsman prefers. However, a handy little instrument known as a 'box square' (Fig.9) may be found to be most useful for transferring longitudinal lines from the shaft end. If a

QUICK TIP

Using epoxy or polyester resin (2)

Don't mix in a plastic cup. The resin dissolves some plastics. Use a paper cup, glass jar or old tin. Small quantities can be mixed on a piece of cardboard.

W J R H Pooler



The guide (centre 2) of photo 4 completed, showing keyway and keyed mandrel (below 1)



FIG. 12 SETTING OUT A WOODRUFF KEY IN A TAPERED SHAFT

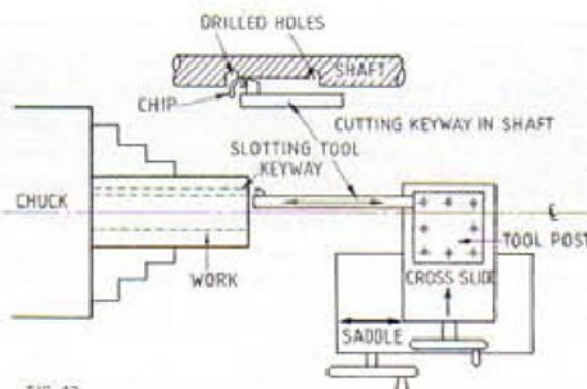


FIG. 13 FORMING A KEYWAY IN LATHE WITHOUT SLOTTING ATTACHMENT

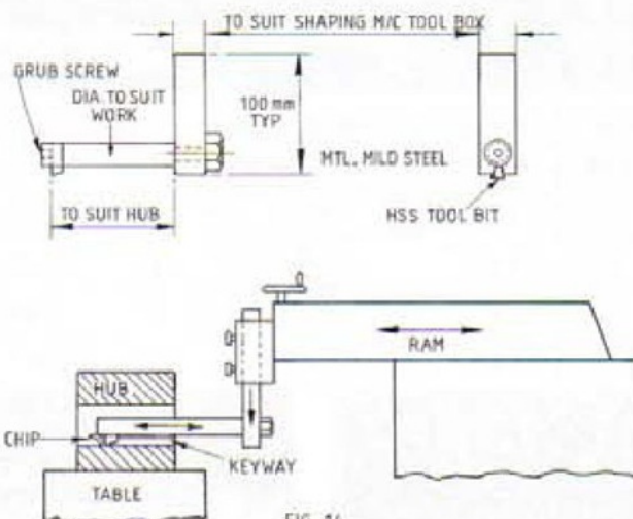


FIG. 14 A SHAPER TOOL FOR HUB KEYWAYS

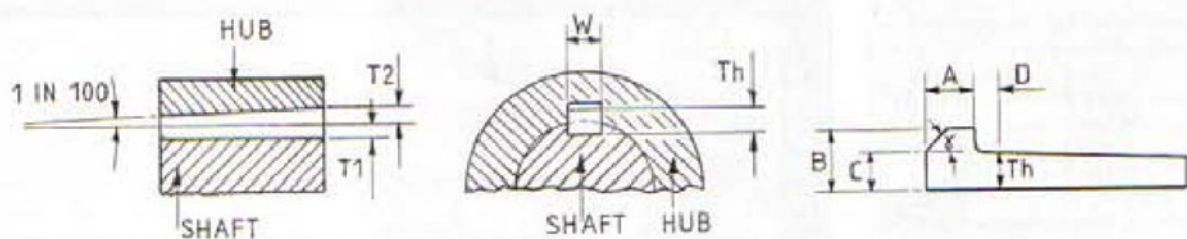


TABLE 2

TABLE 2a
RECOMMENDED METRIC TAPER KEYS & KEYWAYS
FOR MODEL ENGINEERS

SHAFT DIA OVER	UP TO	KEY SIZE W x TH	DEPTH OF KEYWAY INTO SHAFT T1	DEPTH OF KEYWAY INTO HUB T2	STANDARD TOLERANCE FOR T1 OR T2	A	B	C	D	Y
6	8	2 x 2	1.2	0.5	+0.1 -0	2	-	2	2	60°
8	10	3 x 3	1.8	0.9		3	-	3	3	
10	12	4 x 4	2.5	1.2		4	7	4	4	
12	17	5 x 5	3	1.7		5	8	5	5	
17	22	6 x 6	3.5	2.2	+0.2 -0	6	10	6	6	75°
22	30	8 x 7	4	2.4		8	11	7	7	

TABLE 2b
RECOMMENDED IMPERIAL TAPER KEYS & KEYWAYS
FOR MODEL ENGINEERS

SHAFT DIA OVER	UP TO	KEY SIZE W x TH	DEPTH OF KEYWAY INTO SHAFT T1	DEPTH OF KEYWAY INTO HUB T2	STANDARD TOLERANCE FOR T1 OR T2	A	B	C	D	Y
1/4	1/2	1/8 x 1/8	0.072	0.039	+0.0006 -0	3/16	1/4	1/32	0.1	45°
1/2	3/4	3/16 x 3/16	0.107	0.067		1/4	3/8	1/32	0.2	
3/4	1	1/4 x 1/4	0.142	0.094		5/16	7/16	1/32	0.2	
1	1 1/4	5/16 x 5/16	0.177	0.121		3/8	7/16	1/32	0.3	

QUICK TIP

Masonry nails and pin punches

Useful small pin punches in various sizes can be made using masonry nails. Remove the heads and insert in axial holes drilled in short lengths of bright steel of appropriate diameter. Keep the exposed length of nail as short as possible for the job in hand as they can be brittle. Use adhesive if necessary to secure.

J.W.Frazer

box square cannot be acquired, (few dealers stock them nowadays) an effective device can be made up in the workshop using a standard 150mm rule and details are provided for anyone who is interested in making a set

Fig.10 illustrates the practice of cutting a keyway in a shaft using only a drilling machine to start the operation off. The rest of the work is carried out using hand tools. As can be seen, two holes drilled on the centre line of the shaft are deeper than the proposed depth of the finished keyway and of the same diameter as the width of the key. The holes are drilled at each extreme end of the keyway. Of course, if the keyway runs to the end of the shaft only one hole is necessary. Where this is the case, the remaining metal can be removed by using a narrow cross cut chisel, but on a keyway such as that which is shown a 'key seating chisel' (**Fig.11**) will

be a superior tool to use as it can be held at a more accessible angle. It is surprising how, with a little practice, accurate slots can be cut but as good a finish as possible should be strived for. When the craftsman is satisfied with his chisel work, the keyway may be finished off with an unusual file called a 'key seating file' (**Fig.11**) This small file is angled so as to allow access to the bottom of the slot and it can be used to form a smooth flat surface for the key seat itself. I have never ever seen a file like this stocked by any supplier and I surmise that they have always been made by the person who is going to use it. All I do to make mine is take a small file of a suitable size and heat it to cherry red with a blow torch. It is then carefully bent to the required angle and re-heated to cherry red. It can now be immediately quenched and put into use. No tempering is necessary. The hand cut

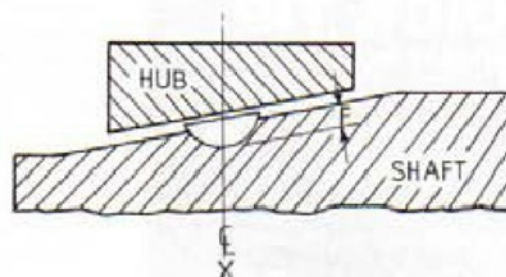
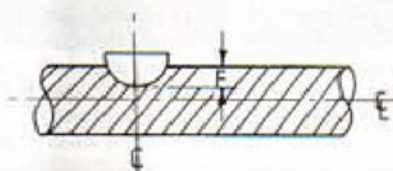


TABLE 3

TABLE 3a

RECOMMENDED WOODRUFF KEYS & KEYWAYS FOR MODEL ENGINEERS

KEY No.	SIZE OF KEY W - DIA	DIAMETER OF KEY	DEPTH OF KEY 'B' MAX - MIN	DEPTH OF KEYWAY IN SHAFT 'F' MAX - MIN	DEPTH OF KEYWAY IN HUB AT X MAX - MIN
203	$\frac{1}{16} \times \frac{1}{8}$	0.375 - 0.370	0.171 - 0.166	0.135 - 0.140	0.042 - 0.047
303	$\frac{3}{32} \times \frac{3}{8}$	0.375 - 0.370	0.171 - 0.166	0.119 - 0.124	0.057 - 0.062
403	$\frac{1}{8} \times \frac{1}{8}$	0.375 - 0.370	0.171 - 0.166	0.104 - 0.109	0.073 - 0.078
204	$\frac{1}{16} \times \frac{1}{2}$	0.500 - 0.490	0.203 - 0.198	0.167 - 0.172	0.042 - 0.047
304	$\frac{3}{32} \times \frac{1}{2}$	0.500 - 0.490	0.203 - 0.198	0.151 - 0.156	0.057 - 0.062
404	$\frac{1}{8} \times \frac{1}{2}$	0.500 - 0.490	0.203 - 0.198	0.136 - 0.141	0.073 - 0.078
LARGER SIZES FOR VEHICLE RESTORERS ETC.					
305	$\frac{3}{32} \times \frac{3}{8}$	0.625 - 0.615	0.250 - 0.245	0.198 - 0.203	0.057 - 0.062
405	$\frac{1}{8} \times \frac{3}{8}$	0.625 - 0.615	0.250 - 0.245	0.182 - 0.187	0.073 - 0.078
505	$\frac{3}{16} \times \frac{3}{8}$	0.625 - 0.615	0.250 - 0.245	0.167 - 0.172	0.089 - 0.094
406	$\frac{1}{8} \times \frac{1}{2}$	0.750 - 0.740	0.313 - 0.308	0.246 - 0.251	0.073 - 0.078
506	$\frac{3}{16} \times \frac{1}{2}$	0.750 - 0.740	0.313 - 0.308	0.230 - 0.235	0.089 - 0.094
606	$\frac{3}{16} \times \frac{3}{4}$	0.750 - 0.740	0.313 - 0.308	0.214 - 0.219	0.104 - 0.109

TABLE 3b

MINIATURE WOODRUFF KEYS & KEYWAYS (ANSI)

KEY No.	SIZE OF KEY W x DIA	DIAMETER OF KEY MAX - MIN	DEPTH OF KEY B MAX - MIN	DEPTH OF KEYWAY IN SHAFT F MAX - MIN	DEPTH OF KEYWAY IN HUB AT X MAX - MIN
202	$\frac{1}{16} \times \frac{1}{16}$	0.268 - 0.250	0.104 - 0.099	0.0778 - 0.0728	0.0372 - 0.0322
202.5	$\frac{1}{16} \times \frac{3}{16}$	0.330 - 0.312	0.135 - 0.130	0.0988 - 0.1038	0.0372 - 0.0322
302.5	$\frac{3}{32} \times \frac{3}{16}$	0.330 - 0.312	0.135 - 0.130	0.0832 - 0.0882	0.0529 - 0.0479

hub is simply marked out and then chiselled and filed out to the correct dimensions. If a scrap piece of bar is on hand which is the same diameter as the bore of the hub, it can be placed inside the hub as a plug and a pilot hole can be drilled for the chisel work, half into the hub and half into the plug.

Milling Keyways

I have cut many a keyway with a hammer and chisel in my home workshop and regard this as a sound method of executing the work, never-the-less, I was very pleased, some years ago, when I was able to equip

QUICK TIP Wetting agent for flux.

When using borax, or silver-soldering flux powder, add a single drop of washing-up liquid. This will ensure that the mixture wets the metal properly without overrun

J.W.Frazer

myself with a small vertical milling machine. This made the forming of keyways in shafts extremely simple and accurate. All that was now required to produce a keyway was to mount a cutter in the spindle (preferably but not necessarily the same size as the key), centralise the

QUICK TIP Four-jaw adjustment

When aligning work in a four-jaw independent lathe chuck, use two chuck keys simultaneously in opposing jaws. Loosen one and at the same time tighten the other. In this way, you shouldn't lose your sense of direction.

J.Gascoyne

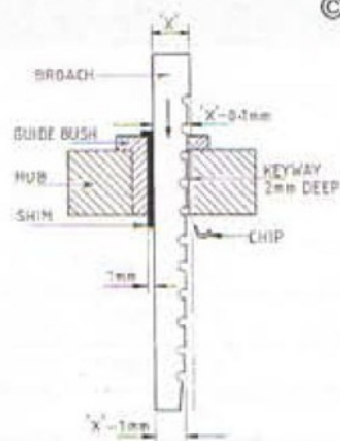


FIG. 15 KEYWAY CUTTING WITH BROACH

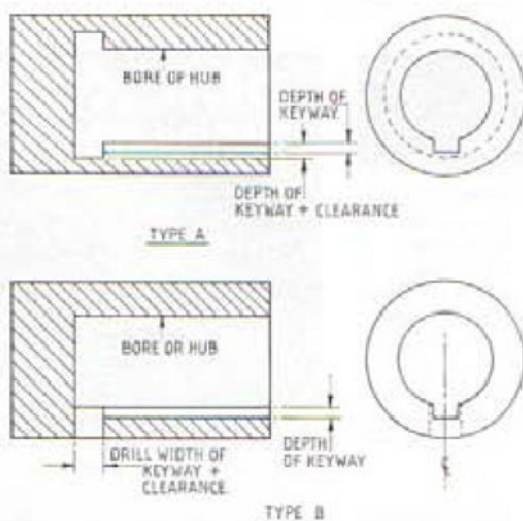


FIG. 17 BLIND KEYWAYS

cutter in relation to the work and remove the metal, no pre-drilling of holes being required. To cut an accurate parallel keyway in the vertical miller, the most suitable cutter to select is a slot drill. For one reason, it is possible to plunge into the work from above with this type of cutter, but it is also manufactured to closer tolerances than the end mill. The end mill may be as much as 0.05mm oversize for cutters up to 12mm diameter and still remain within tolerance limits. On the other hand the tolerance on a 12mm slot drill is -0.032mm to -0.059mm. Provided that it is running true in the machine spindle, the slot drill will produce accurate keyways. In addition to cutting accurate work, it is unnecessary to mark out the keyway when using machinery. The work can be precisely centralised using the machine leadscrew by touching in with the cutter and moving across a further amount of half the shaft diameter plus half the cutter diameter. The shaft will, of course, have to be parallel with the axis of the machine table and a good way to ensure this is to clamp the shaft into a T-slot.

To cut a Woodruff key is simplicity itself. A commercially made cutter may be used or it is a simple matter to make your own, having the correct radius and width. They are used in the vertical milling machine and are fed in from the side of the shaft instead of from the top as is the case with the slot drill. If the keyway is to be cut in a tapered

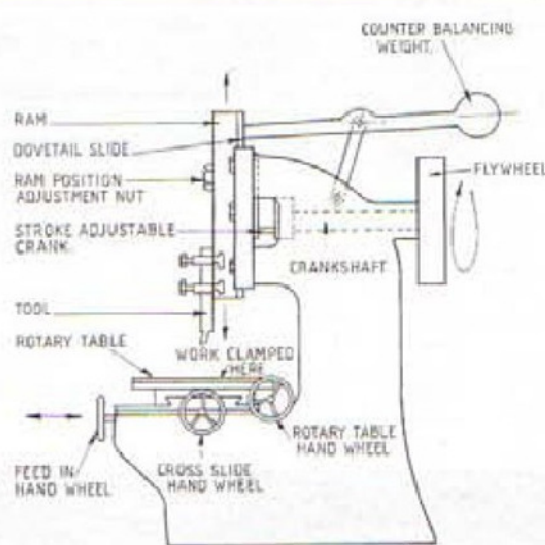
shaft, the set-up is as shown in Fig. 12.

Keyways may also be cut with the horizontal milling machine. A circular cutter of any diameter may be used, but the keyway will not terminate square to its base, rather as a segment of a circle equal to the radius of the cutter. This makes the total length necessary for a keyway considerably larger than one which has been produced on a vertical machine. If the keyway runs the full length of the shaft, it will appear no different to one cut vertically.

Other Methods

An acceptable keyway may be cut in the lathe by reverting to drilling two holes in a similar fashion to cutting with the chisel, but then setting the work up in the lathe and centralising a grooving tool, of the correct width, between the holes (Fig. 13). The saddle is manipulated back and forth, taking light cuts of say 0.05mm, and the tool is fed in with the cross slide until the required depth has been achieved.

A similar result can be obtained by the use of the shaping machine, except that the cutting is accomplished under power (assuming it is not a hand shaper). The stroke must be adjusted so that the tool reciprocates between the holes and a compressed air blow gun is useful to clear swarf from the groove as work progresses. If this swarf is allowed to build up in the



THE SLOTTING MACHINE

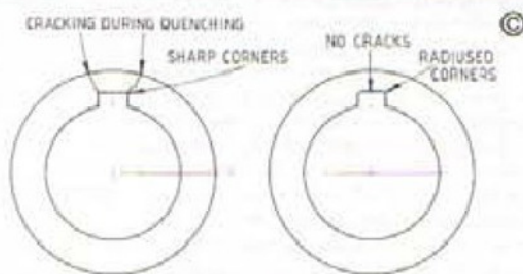


FIG. 16 HEAT TREATED HUBS

**TABLE 5
METRIC WOODRUFF CUTTERS**

W	x	DIA
2	x	10.5
2.5	x	10.5
3	x	10.5
2	x	13.5
2.5	x	13.5
3	x	13.5
4	x	13.5
2.5	x	16.5
3	x	16.5
4	x	16.5
5	x	16.5
3	x	19.5
4	x	19.5
5	x	19.5
6	x	19.5

groove, it can become trapped between the end of the keyway and the tool. As it is cleared, either by air or by brush, the machine must be stopped (and eye protection remain in place). Shaping machines are capable of inflicting terrible injuries upon hands and fingers.

Slotting attachments can be made in the home workshop which are fitted to the lathe or even the milling machine and are excellent for keywaying hubs, especially if the keyway in question is to be tapered. These are invariably hand-lever operated contrivances which reciprocate as the operator wills, taking light cuts as the cutting tool travels along the bore, and eventually forming a keyway of the correct dimensions. A hub can be slotted in the lathe without the aid of a slotting attachment in much the same manner as the shaft is machined and Fig.13 also

illustrates this method.

Returning to the shaping machine, this item of equipment is also quite capable of producing accurate keyways in hubs. We have already seen how a keyway in a shaft can easily be formed and the keyway in its matching hub is possible with a simple tool which can be made in most home workshops (Fig. 14). Accurate setting of the stroke is required with this tool, but once set up the results are very good. Although the shaping machine has lost favour in the industrial domain, it is a most useful item for the home workshop.

Earlier it was stated that keyways can be produced with the aid of a press and this is quite true. Hubs can be furnished with a suitable keyway by forcing a cutting tool, which is centralised by a bush, through the bore from which it removes metal in gradually increasing stages as it is pressed forward. This type of tool is called a broach (Fig.15) and a separate tool is required for each size of keyway. A set of standard keyway broaches and bushes is an enviable acquisition, but are very expensive. A single pass with a broach may not be sufficient to cut a keyway of the desired depth and if this is the case, a shim is placed between the broach and the bush and the process is repeated until the correct depth has been achieved. For example, if a broach cuts a keyway which is 1mm deep in one pass and a 2mm deep keyway is specified, then a 1mm shim is used for the second pass. Should the keyway need to be 3mm deep, 3 passes

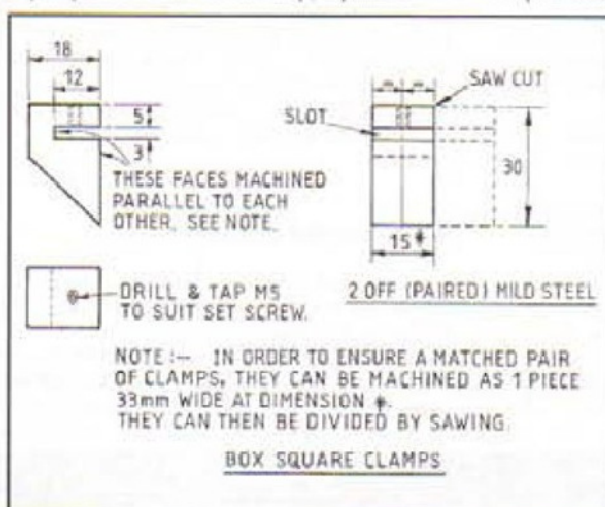
will be required, each pass being shimmed by 1mm.

Blind Keyways

From time to time, blind keyways may have to be produced in hubs, an example being a coupling where one shaft size is smaller than the second. Clearly it is impossible to cut a keyway in the larger end which is (for the purpose of the keyway), blind. Fig.17 shows a couple of solutions to the problem, both of which work successfully. Type A is where a recess is turned in the back of the hole, the diameter of which is sufficient to provide a clearance when the slotting tool exits the back of the keyway. Plenty of space is provided here for the accumulation of swarf as the keyway progresses. Type B is where a hole is drilled at 90 degrees to and on the same centre line as the proposed keyway, the diameter of the hole being slightly larger (e.g. 2mm) than the width of the keyway. As the slotting tool exits the keyway here the swarf is catered for by the hole and chips can be removed from the job through this orifice. The hole can later be plugged if required.

It is hoped that the amateur engineer in his small workshop at home may now be able to tackle the matter of providing suitable keys and keyways for his particular needs. With the correct approach there is no reason why perfect keyways should not be produced and any special tooling which

has been made will, in all likelihood come in handy on future projects. Tables are included in order to help select a key & keyway which is suitable for the job and which is recognised in this country as the standard keyway for that particular shaft diameter. This makes life very much easier when buying standard pulleys, couplings, sprockets, etc., as these will have been manufactured to the same standards and no alterations should be required. It is, therefore, recommended that standard keys & keyways should be adhered to whenever possible.



QUICK TIP Easy view drill sizes

Some drill boxes have hard to read stamped sizes. To improve these, remove the drills and clean the numbered faces thoroughly, getting into the indentations, then paint over with Tippex or white paint, making sure to fill up the numbers. When thoroughly dry, remove the surplus with a sharp edged tool, leaving the crevices filled for easy reading.

Malcolm Richards

**TABLE 4
OBSOLETE DESIGNATION OF
WOODRUFF CUTTERS**

CURRENT	KEY SIZE	OLD No.
204	$\frac{1}{16} \times \frac{1}{2}$	1
304	$\frac{3}{32} \times \frac{1}{2}$	2
404	$\frac{1}{8} \times \frac{1}{2}$	3
305	$\frac{3}{32} \times \frac{5}{8}$	4
405	$\frac{1}{8} \times \frac{5}{8}$	5
505	$\frac{3}{32} \times \frac{3}{4}$	6
406	$\frac{1}{8} \times \frac{3}{4}$	7
506	$\frac{3}{32} \times \frac{3}{4}$	8
606	$\frac{1}{8} \times \frac{3}{4}$	9

Box Square Clamps

These simply constructed clamps are a useful addition to the marking out equipment of the workshop. A common 150mm steel rule (or any other suitable straight-edge) is placed into the slots and clamped there using brass set screws, making sure that it is firmly against the back of the slot.

The assembly can now be used to mark out lines on a round bar in a longitudinal plane. If the clamps are made in one piece as described in the note, they are exceptionally accurate as a means of marking out keyways.

They can be made any size the engineer requires to suit the work he is likely to encounter. Several sets are to be recommended and larger ones are an excellent addition to a combination square set.



DRAW BARS

Jim Canner encourages us to treat these relatively simple pieces of equipment with a little more respect and suggests a design which will hold its own alongside more elaborate items of tooling.

Draw bars are generally treated as a second rate piece of equipment in the model engineer's workshop, often being just an odd bit of screwed rod that is also used as a knocking bar.

Let me first make a distinction, draw bars and draw tubes are different pieces of kit. A draw tube is a precision item, generally used to close collets and making use of a fine thread and precise fits. You don't knock these about unless you want to spend money for no good reason. I will not discuss draw tubes here as they deserve an article in their own right. A draw bar is seldom treated with the respect it deserves, but would be more so if it looked and felt like a 'nice' piece of equipment.

I will relate here some of the rules I apply for making 'nice' draw bars for several diverse duties around my workshop, which comprises a Super 7, Centec mill, three drilling machines and several items that could be broadly classified as DIY. Draw bars are intended to operate through a hollow spindle in order to hold a tool firmly to that spindle. Draw bars usually have a thread at the tool end engaging with the tool, and a handle at the other. The tool may be mounted on a taper

of some form which is threaded to accept the draw bar thread. I know of no standards for draw bars, but even if there were it is doubtful if any model engineers would comply with them!

The thread is of a hand which tends to tighten the tool into the taper during operation, but this tightening must not be excessive or large removal forces may be necessary. Sometimes you may come across drills or milling cutters that have Morse tapers with a threaded hole in them. These can be very handy and at the right price you should buy them!

A typical model engineer's draw bar is shown in Fig.1. This is just a length of screwed rod with a handle fixed to it by any old bodge, or worse still, just a nut and washer. This will work, but be a source of annoyance to you for ever, and you wouldn't like to spoil the joy of your hobby would you? You only have to handle something like that to feel it is wrong and the chances are you will lose the washer anyway. If you don't use a washer you should not be in this game. In addition, this kind of bodge will leave you cursing and wagging the bar around trying to find the threaded hole. Serves you right!

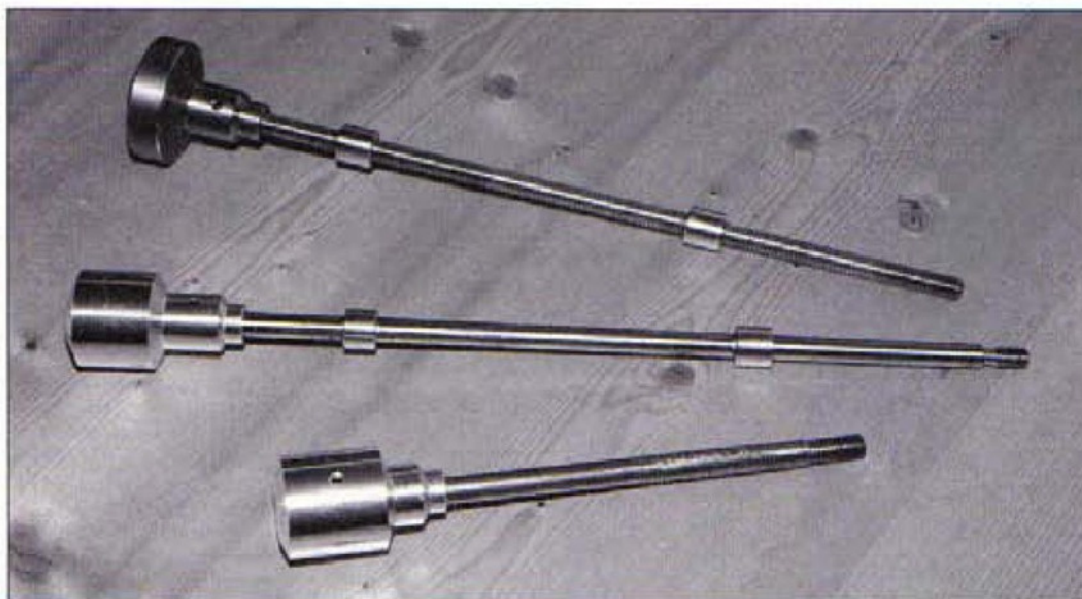
So, let's design something to do the job properly which, once made, we can be proud of.

A suggested design

I think first it might be best to decide how many draw bars we need, the type of thread at the tool end and the length required for proper engagement. Also, note the bore of each spindle for which you need a bar. To the length add about 2in. extra on which to fit the

handle. As this handle needs to be about 2in. diameter and 2.5in. long in either brass, cast iron or aluminium, we are talking of a hefty lump of metal that may cost a few bob or more. With this in mind I have devised a system where we may only need one handle for several draw bars. Changing it is quick and easy and will do until you search out suitable lumps of metal at car boot sales and the like to make more handles. I have this very problem at the moment where I don't want to use my valuable lumps of 'stock' for mere handles.

Perhaps a supplier can produce a nice double ended casting for us in aluminium, so we can get two handles for the price of one. I have carved three handles out of the solid so far and don't feel I want to either spend more money or tread more swarf into the house! The handle is machined as generally shown in Fig.2, with a blind tapped hole down the centre about 3/8in. BSF and a plain lead about 1in. long the same diameter as the draw bar material. The draw bar should be in mild steel and have a thread at one end to suit the tool, with a nicely formed end, and one at the other end to suit the handle. I recommend that these should be screw cut, even if it means final finishing with a die. Both threads should be an easy fit, but a fit! Prior to screw cutting, machine the bar to core diameter to provide a runout. You can use a screwed rod, but avoid if possible. Give the bar a bit of a clean up for the sake of appearance and then file a flat on the thread at the handle end (along the thread only) until a significant width of the thread core is showing. This is the place where the handle grub screw will bed. Run the die down again and lightly wire brush to get rid of all the burrs. Before drilling and tapping for the grub screw (2BA), assemble the handle and drawbar and try in the machine. When you are satisfied that you have a close enough fit, decide where the



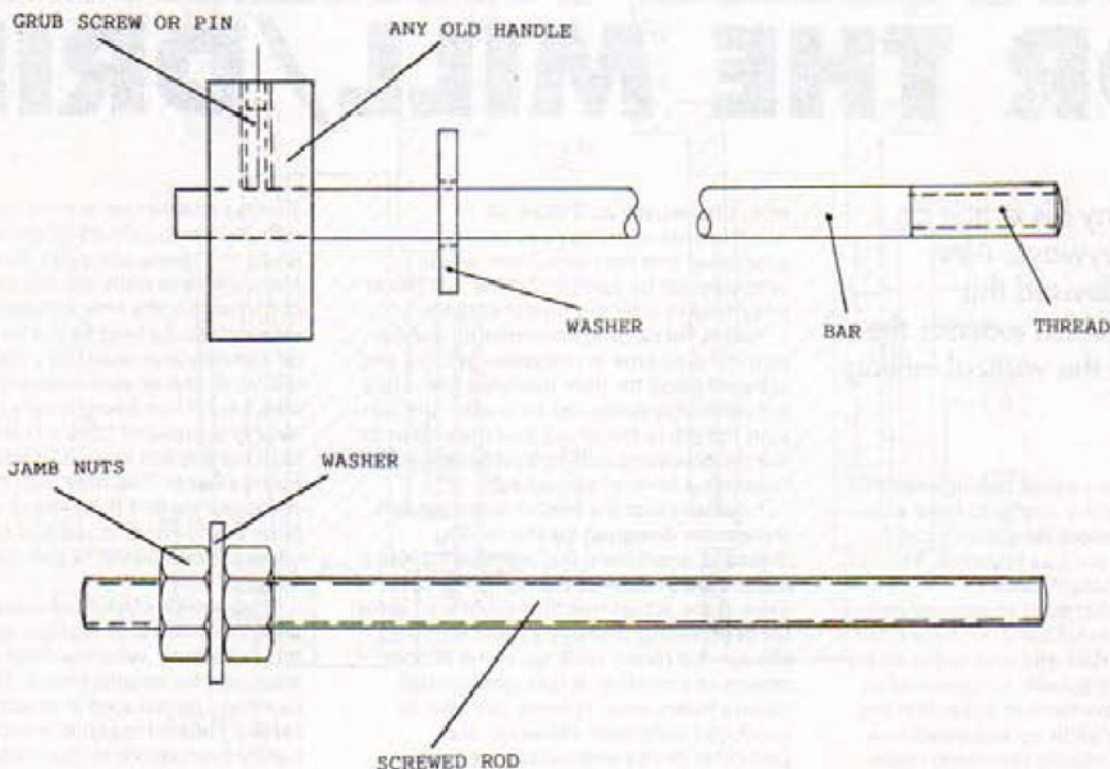


Fig. 1

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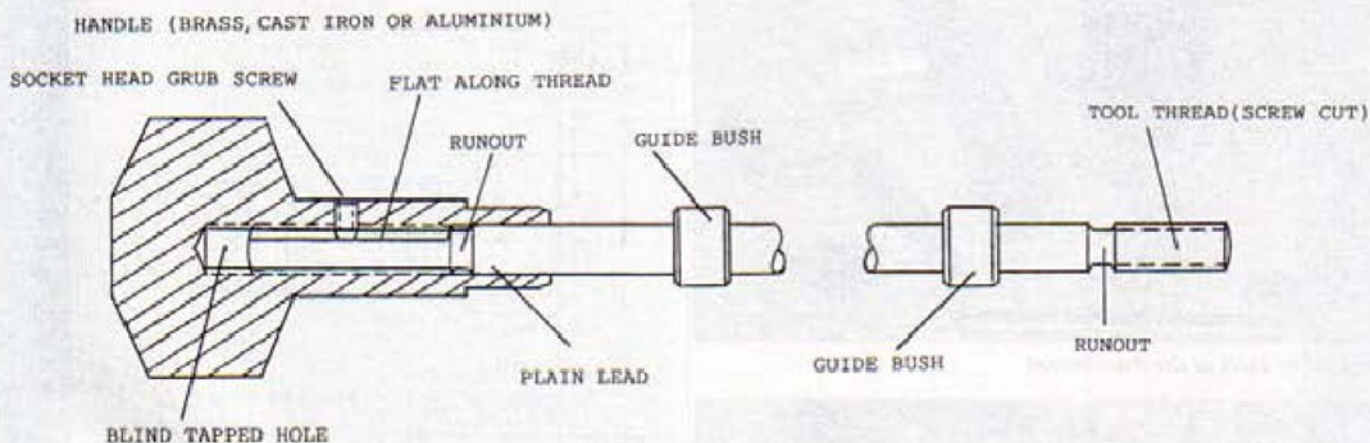


Fig. 2

©

grubscrew should go to locate in about the middle of the length of the flat. If you are going to use a single handle for several bars, remember that the handle should be sized for the largest bar and the smaller ones may need to be turned smaller over the length protruding from the handle. Drill and tap the handle 2BA and use a socket head grub screw.

You now have a handle that can be adjusted by one thread pitch at a time and be clamped by the grub screw. When in use, the axial load on the thread stops the handle

coming off and the grub screw simply stops it rotating on the bar. Very satisfactory! To fit the handle, mount the bar horizontally in the vice with the flat uppermost, screw on the handle and then fix by setting at the right place, with the grub screw vertical. This is a nice way of doing things because, in use, if the screw loosened or fell out there would be little effect on the clamping of the drawbar.

In the photograph my handles do not comply with the rules for size, I simply used the materials I had available and the diameters were judged appropriate for the job

in hand. The right material is seldom available to us! Now another nice touch. It is desirable that the drawbar and tool thread be in line to ensure engagement first time. To this end I choose to "glue", using one of the proprietary adhesives, a pair of bushes to the bar to enable it to line up fairly closely. These are a few thou. smaller than the spindle bore (This is 0.620in. for my Super 7). These bushes can be almost any material that will adhere, but remember to degrease (I use surgical spirit). If you wish to mill notches around the edge of the handle, go ahead and do so



A SLOTTING ATTACHMENT FOR THE MILL/DRILL

To accompany his article on Keys and Keyways, Alan Jeeves has devised this attachment which extends the versatility of the vertical milling machine.

If you possess a vertical milling machine it will be extremely useful to have a slotting attachment for it which can be used to cut slots such as keyways. Most of the industrial quality machine manufacturers offer such an accoutrement by way of an optional extra which is fitted to the machine arbor and where the rotary movement of this spindle is converted to reciprocating movement in order that the slotting ram may slide up and down in a vertical plane, gradually removing metal

from the keyway as it does so. Attachments of this type are very expensive and the cost of one would probably not be justified by the incidental use made of it by the model engineer.

Self build slotting attachments appear from time to time in magazine articles and are very good for their intended use. They are invariably designed for use on the lathe with the job in the chuck and the power for the reciprocating cutting tool provided by hand via a lever of some kind.

I realised that if a similar arrangement were to be designed for the milling machine, apart from the operator having a much clearer view of the work, the two axes of the actual machine table are perfect for centralising the keyway and applying the cut. If a rotary table (or some simple means of indexing) is brought into use, square holes, even splines, can also be produced with ease. However, this particular device will cut square holes

without the need for indexing equipment as we shall see later.

The particular machine for which I designed this

slotting attachment is a standard Taiwan manufactured mill/drill and marketed under the name of the Nu-Tool MD 350 but many of these mills are identical in construction, the only difference being the name plate. As long as the attachment can be securely mounted onto the quill collar it will work just as well with any machine. My attachment has been heavily constructed, having a stroke of 75mm and many may feel that it is too large for their requirements. The drawings shown demonstrate that this type of slotter can be fairly easily constructed and may, of course, be re-scaled to suit individual needs.

The normal stroke provided on many lathe mounted attachments appears to be around 50mm, which is often quite adequate for amateur work. This device can then, be reduced in length to suit a certain piece of material which may be handy from which to manufacture it.

Materials

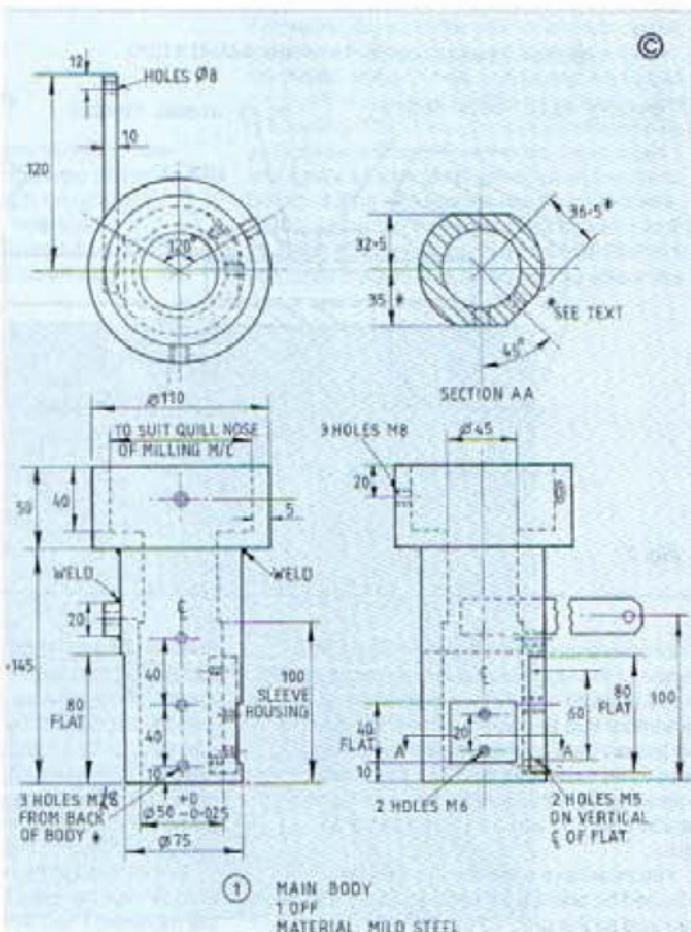
The basic materials from which the slotter is constructed can easily be obtained from various sources, the scrap



Component parts of the Attachment



Square bar ready to turn for the ram.



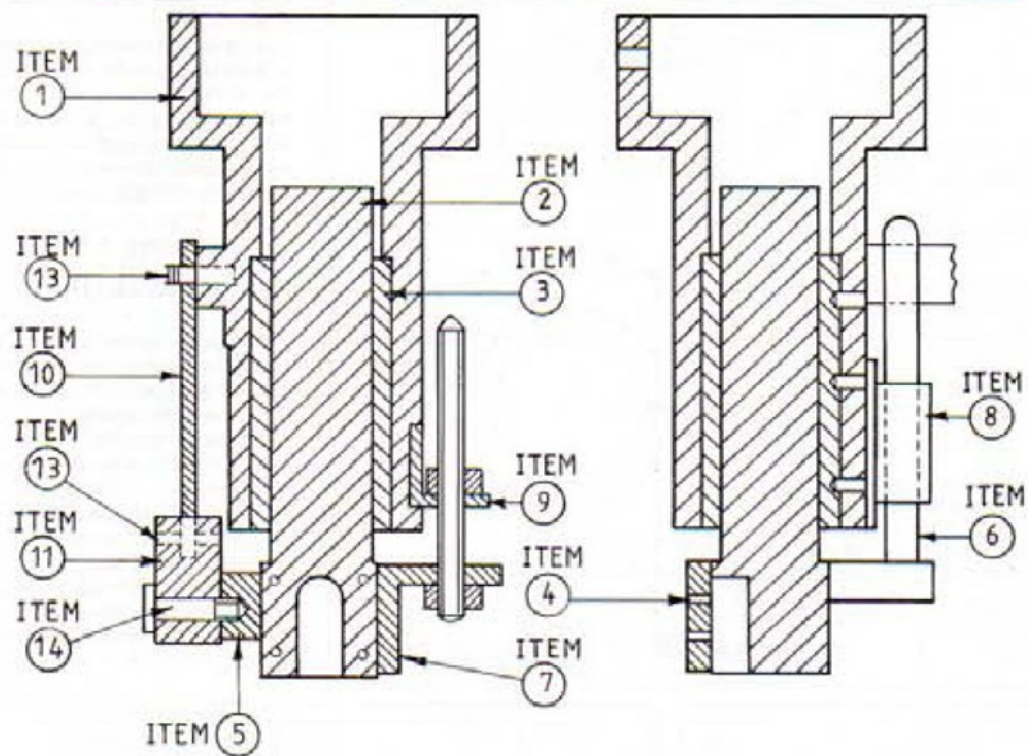
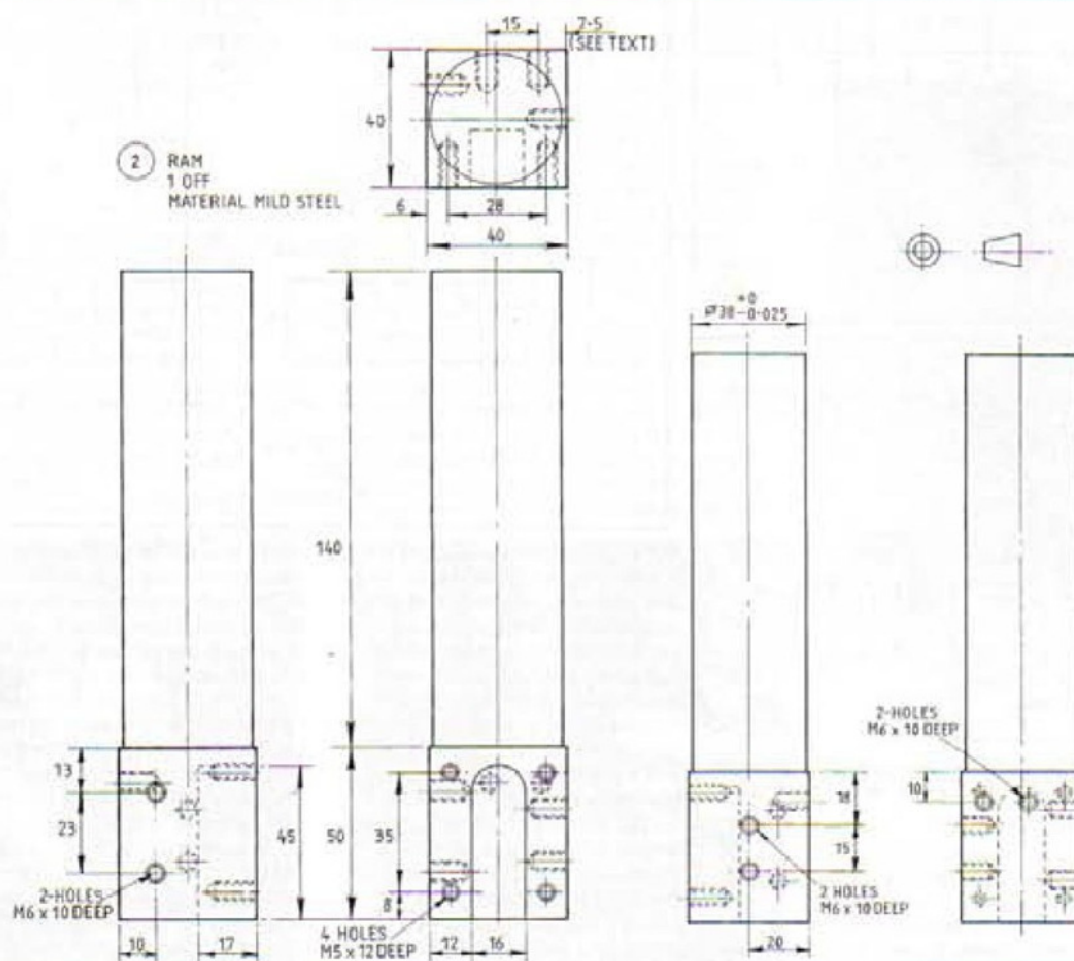
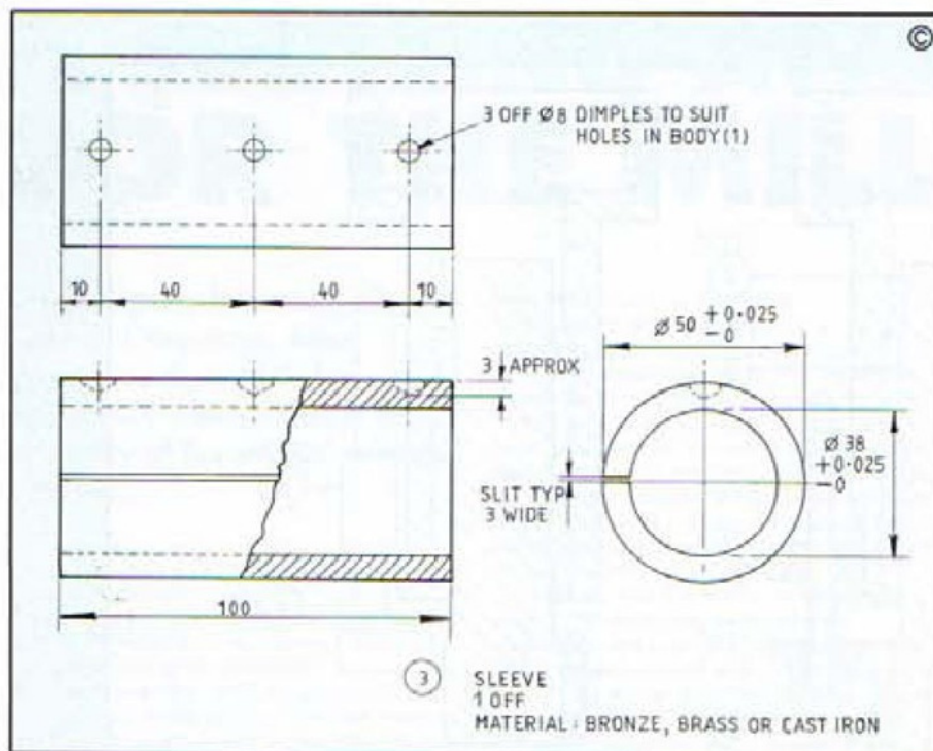


FIG. 1 ASSEMBLY DRAWING





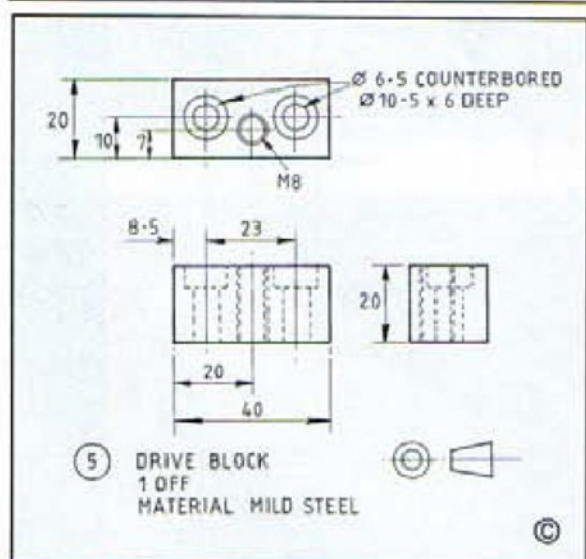
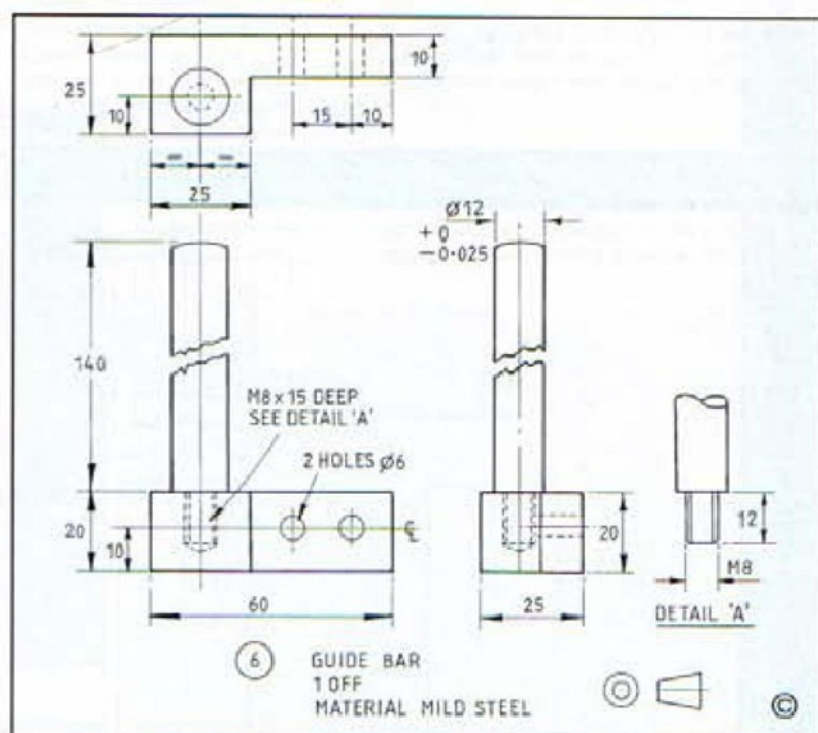
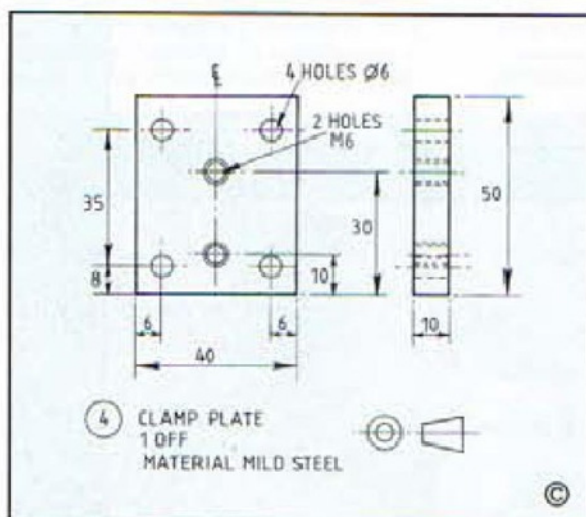
carbon steel is accidentally used. The body may be made from solid bar, though, if preferred.

I made the ram out of a piece of 1½ in. square bright mild steel (BMS) and turned the 38 mm diameter in the 4-jaw chuck, using a centre to support it, and then reduced the remaining square portion to 40 mm in the milling machine. All the other items were made from stock material off the bar rack.

Starting Work (The Body)

I chose to make the body (Item 1) first and get a large piece of metal out of the way. The fabrication (after welding) was set up in the lathe and gripped on the largest diameter (the collar) in the 4-jaw chuck as a sturdier grip is always obtained with the 4-jaw. The 75mm diameter was skimmed up true in case a steady was needed (it wasn't) and the first end was bored out to 50mm diameter for a depth of 100mm to accommodate the split sleeve (Item 3). Much care was taken to machine the bore dimensionally accurate and also parallel.

The job was turned around in the 4-jaw



bronze, but brass or cast iron will suffice also. It will be seen that this sleeve is split longitudinally, the purpose of the slit being to provide the adjustment which will allow the take-up of any wear which may occur in due course (it being essential that the ram is a good fit in the sleeve) but a plain rigid bush may be used if preferred.

The body is made from two pieces of mild steel which are quite separate. One is a piece of 3in. by 1in tube and the other is an old steel collar, the two having been welded together as a fabrication. The maker must be sure that the materials are of a low carbon content (below 0.4%) if welding is to be employed, as the fabrication can end up hard and difficult to machine if higher

carbon steel is accidentally used. The body may be made from solid bar, though, if preferred. In the case of the Nu-Tool it is 90mm and it should be made a nice sliding fit so as to keep it square when the three M8 grub screws are tightened.

The body can now be transferred to the milling machine to have all the flats milled on. The 40mm high flat on the right hand side will be used for the depth stop system. The flat at 45 degrees to the depth stop flat is to be used for the guide bar bush (Item 8), while the large 80 mm long, full width flat on the left hand side is simply additional clearance for the lever handle when in use (some may feel that this is not required). It will pay to machine the first two of these as accurately as possible as they are seatings for components which mate with others attached to the ram, although some adjustment is possible on

yard is a particularly favourite option. The split sleeve (Item 3) was found as a scrap bearing, 150 mm long with a 50 mm outside diameter and a 30 mm bore. Simple re-working of it in the lathe produced the sleeve. This one is made from phosphor-

assembly. The centre to flat distance can be added to half the actual diameter of the body to determine the measurement to be achieved when milling the flat. The mill can now be set up for drilling the various holes shown on the drawing. The three M8 tapped holes along the vertical centre line of the back of the body will house grub screws which will be used to compress the split sleeve if and when any adjustment is necessary. The tapped holes in the flats may be left until **Items 8 & 9** have been drilled and the holes spotted through if this method is favoured. Screws in the three M8 holes at 120 degrees in the collar secure the completed unit to the milling machine and eventually the holes will be spotted through to the machine quill collar, where dimples are drilled to accept the screws. This is a very effective means of mounting the slotting attachment to the parent machine.

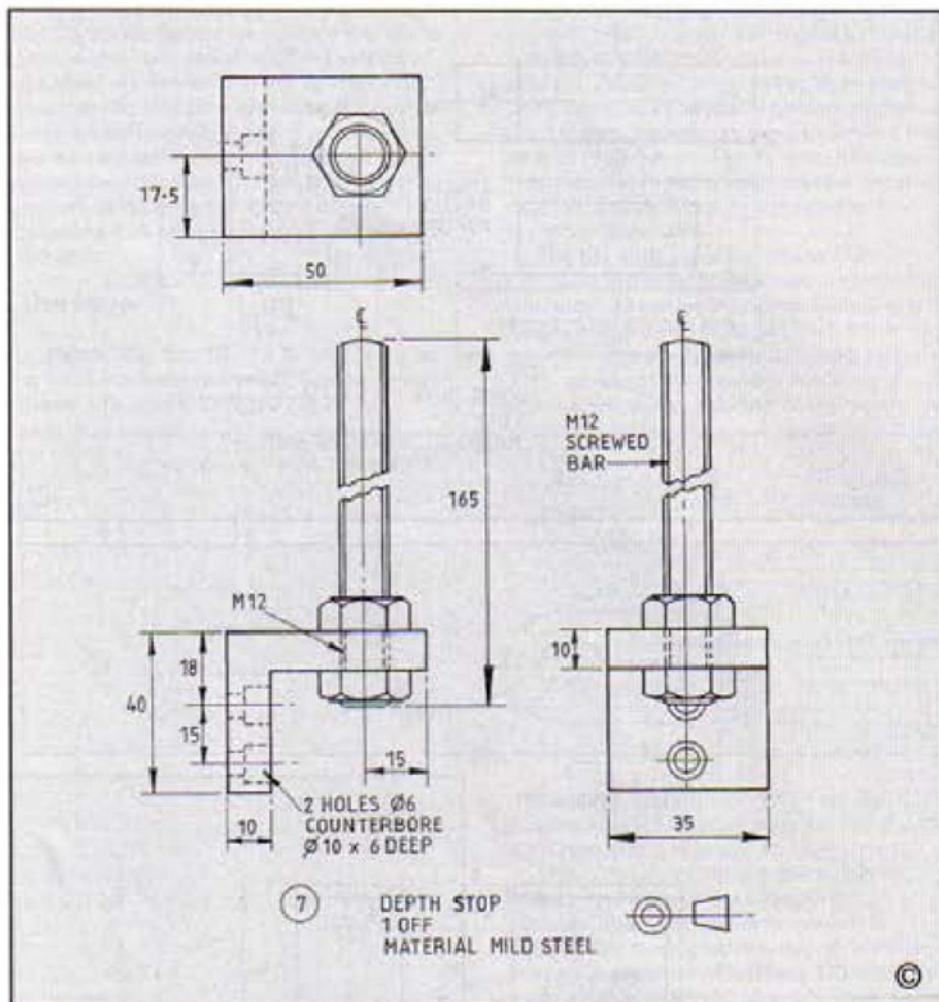
The guide bush (**Item 8**) can be made out of a piece of brass, bronze or cast iron and it is screwed to the body utilising the flat at 45 degrees to the right hand body side. If it does not align exactly with the guide bar (**Item 6**), it may have to be skimmed or adjusted until it does. The flat at the right hand body side is used to mount the depth stop bracket (**Item 9**), which will later be used as a buffer for the adjustable locknuts on the depth stop.

Outrigged from the left side of the body is a 120 mm length of 20 mm by 10 mm mild steel bar. The 8 mm diameter hole at the end is used to indirectly pivot the lever (**Item 11**). The section of the body is substantial enough to weld this bar to it without distorting any previous machining as the weld is relatively small. This weld can be executed with a small 100 amp domestic supply arc welder.

The Ram

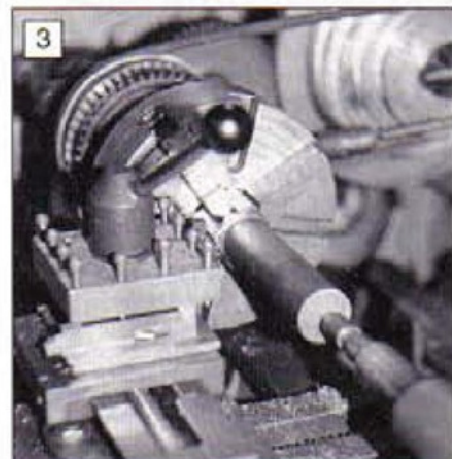
The reason for my electing to make the ram next was that I could also use it as a plug gauge for boring out the split sleeve later. As already mentioned, it was made up out of square bar and turned down in the lathe. Once the corner had been 'broken' the turning was quite easy. Again, care was taken to produce an accurate and parallel section which also possessed a fine finish as it would be sliding up and down in the sleeve.

It will be noticed that a deep slot has

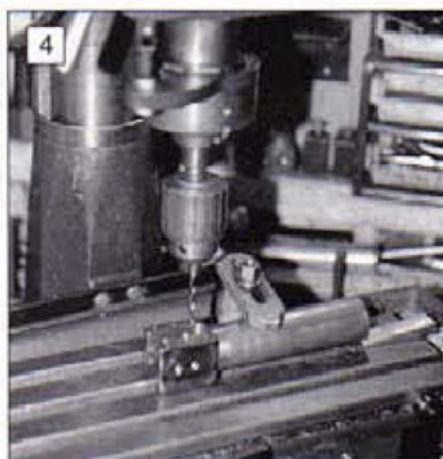


been provided in the front of the square head of the ram (16mm by 17mm by 45mm long). This will be the pocket for holding the cutting tools, which will also be home produced. Four separate parts are screwed to the ram and, as with the body collar, the tapped holes can be left and spotted through when these parts (**Items 4, 5, 6, & 7**) have been made, should you prefer to work this way.

Item 4 is simply a clamp plate which screws to the front of the head of the ram (over the tool pocket) by means of the four M5 screws. The two M6 tapped holes in the plate should fall on the centre line of the tool (when fitted). A couple of screws will then clamp the tool in place when slotting commences. The drive block (**Item 5**) is an



The ram taking shape.



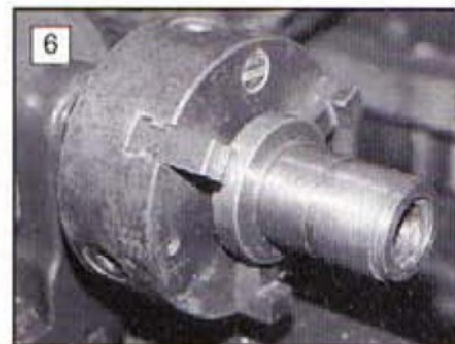
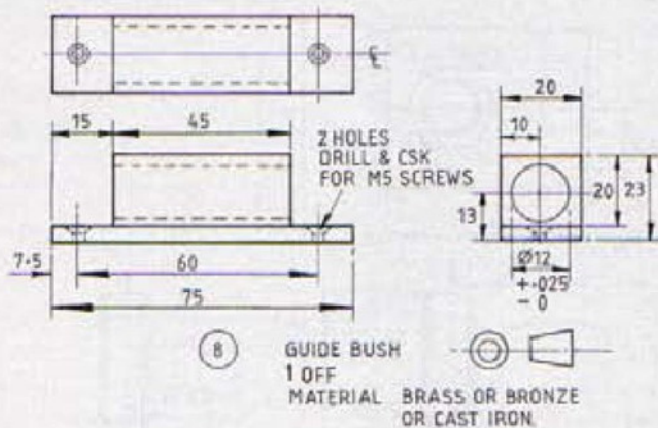
Drilling the ram.



The ram complete with guide bar and depth stop.

easy job and, when completed, screws to the left hand side of the ram. Its purpose is to transfer the energy from the lever handle, which is operated by hand, to the ram by as sturdy a means as is possible.

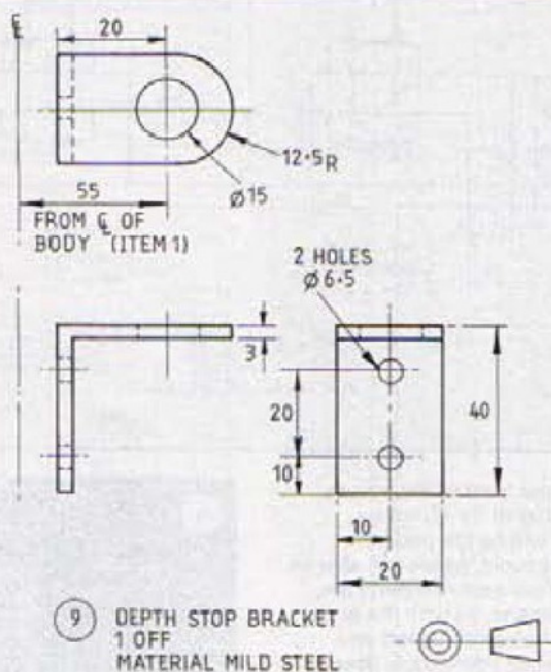
When the ram is travelling along its stroke it is imperative that it is not allowed to twist within the split sleeve (**Item 3**). It is



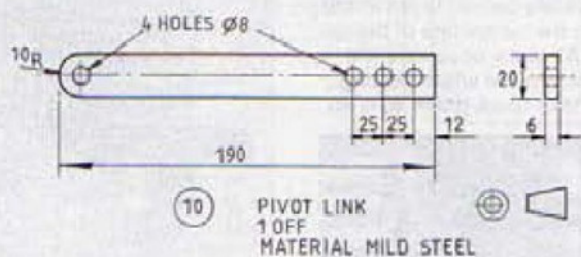
6: Reclaiming a bronze bush for the split sleeve.



Splitting the sleeve in the miller.



Split sleeve in position showing adjusting screws.



vital that the slot or keyway which is being cut is parallel with the axis of the hub which is being cut into. I have, therefore, provided a 12 mm diameter guide bar which screws to the ram at the rear by means of two M6 screws. The bar corresponds with the bore of the guide bush (Item 8) which is, in turn, screwed to the side of the body. It effectively keeps the ram square whilst not being obstructive at the rear of the unit. Spotting through Item

6 while the guide bar is inserted in the bore of Item 8 will help to overcome any tolerance problems.

The depth stop (Item 7) is also a very simple affair. I used a piece of bought in screwed bar, but it can be screw cut in the lathe if required. Its main purpose is to prevent the tool from hitting (and damaging) the milling table. It does, therefore need to be a substantial fitment, as the ram will come to an abrupt standstill

at the pre-determined moment. I actually fitted the depth stop as an afterthought, and many potential makers will see that the depth stop and guide bar may be combined as one item.

The Split Sleeve

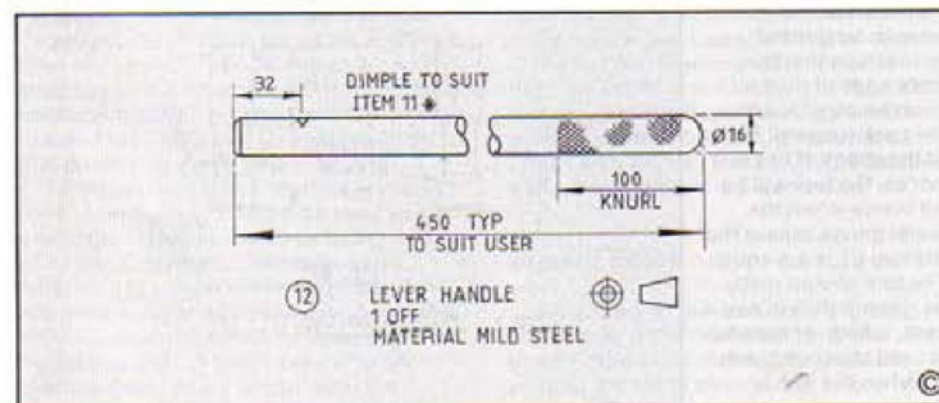
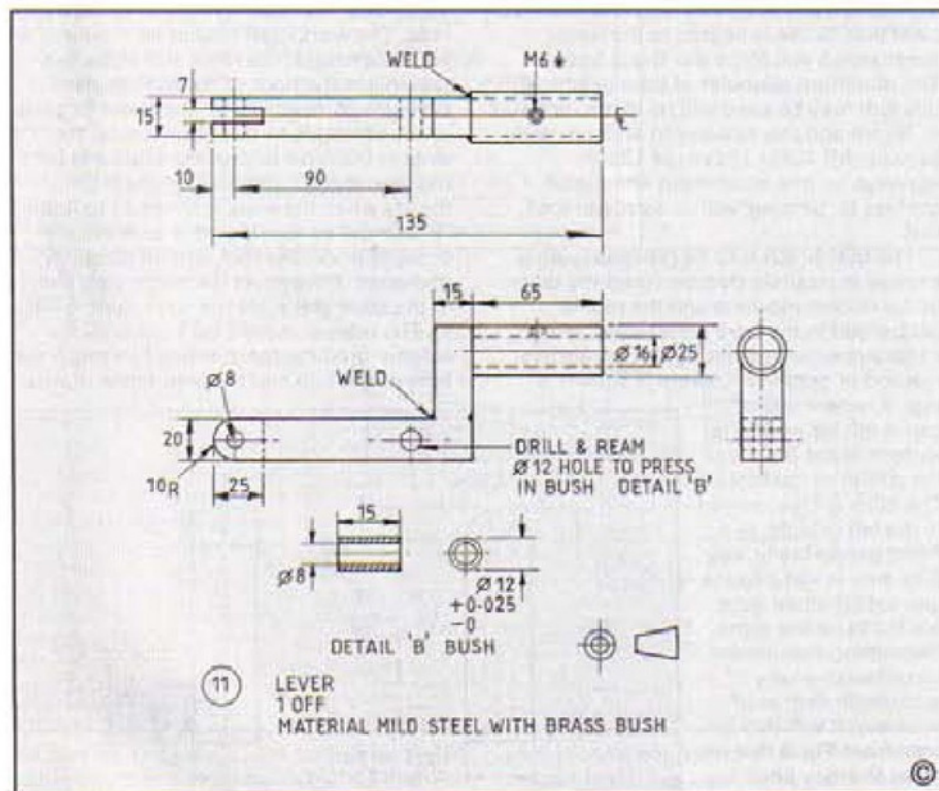
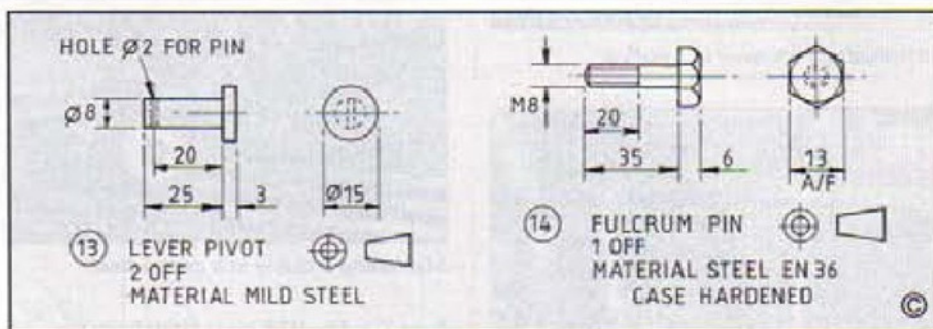
The purpose of the sleeve is to counter the movement of the ram from sliding up and down in a "steel to steel" situation. It must be constructed carefully and accurately, for clearance in the sleeve is not permissible as the tool is likely to deflect from the surface of the hub if play is present. The outside diameter is turned to a nice sliding fit in the body and is dimpled in three places to correspond with the three M8 tapped holes already drilled in it. If you elect to split the sleeve, a neat job is produced in the milling machine, or as an alternative, two blades may be mounted side by side in the hacksaw frame and the



sleeve wall sawn through. As my milling machine was set up for another job at the time when I wanted to split my sleeve, I successfully carried out the operation in the shaping machine. Because the body is already completed, as is the ram, the sleeve can be located into its housing within the body and the three M8 grub screws tensioned to hold the sleeve whilst allowing it to offer a play-free sliding fit for the ram.

The Lever

Items 10, 11, 12, 13 & 14 are made to form the lever assembly. The lever itself (**Item 11**), was fabricated out of



rectangular section. The reason that it was cranked was to cause the handle to be at a comfortable height (for me) and also to prevent the distant end of the lever handle from being too low at the bottom of the stroke. Individuals may wish to amend the design of this item. The 12 mm diameter reamed hole in the lever houses a brass (or cast iron) bush which is intended to be replaced when worn.

The flat strip pivot link (**Item 10**) connects the lever to the anchor welded to the body. At the lever end (radiused) is a single hole for the pivot pin, but at the opposite end are to be found three holes. This arrangement provides some adjustment to the position of the lever.

depending upon the length of stroke required. The two pivot pins are fitted with a washer and a wire clip to retain them.

When the lever handle (**Item 12**) is fitted into the lever it will endure considerable force if it is to drive the cutting tool through the work, so for this reason the fulcrum pin (**Item 12**) is made from a piece of higher strength steel, such as EN36, which may be case hardened to resist wear.

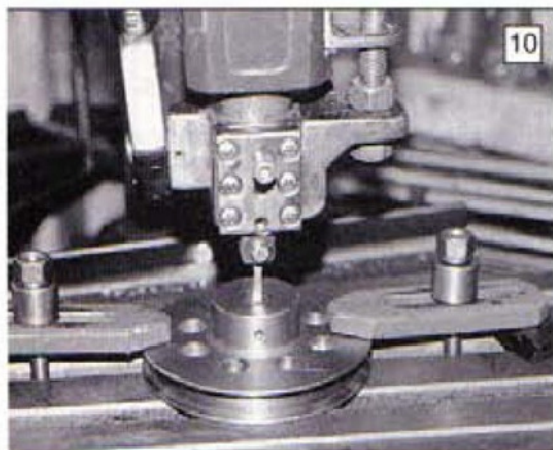
This concludes the manufacture of the separate parts which are required for the slotting attachment.

Assembly

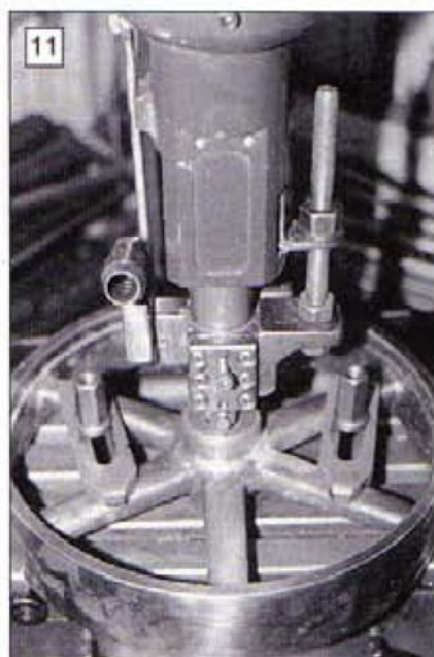
The split sleeve will already have been fitted to the main body of the unit and to fit the guide bush (**Item 8**) and depth stop bracket (**Item 9**) simply screwing them into position on their relative flats is all that is required. **Items 4, 5, 6 & 7** are all fitted to the ram which is offered up to the body and should slide comfortably into the split sleeve, making sure that the guide bar (**Item 6**) accurately locates in the bush on the body.

The lever (**Item 11**) is attached, to the drive block (**Item 5**) using the hardened fulcrum pin (**Item 14**), which is lubricated with oil or grease. The hole through the fork at the end of the lever is fitted with a lever pivot pin (**Item 13**) to connect the pivot link (**Item 10**) and similarly at the anchorage on the body.

It was mentioned earlier that the three M8 tapped holes in the collar of the body would be spotted through onto the quill collar off the milling machine. Before this is done the unit will have to be set square with the axis of the table, or more accurately, the tool pocket will have to be set square. This is necessary to ensure that the keyway which will eventually be cut, is also square with the centre line of the hub. When it is considered that the slotting attachment is positioned as square as



Machining a keyway in a pulley



Cutting a keyway in a 12in. flywheel.

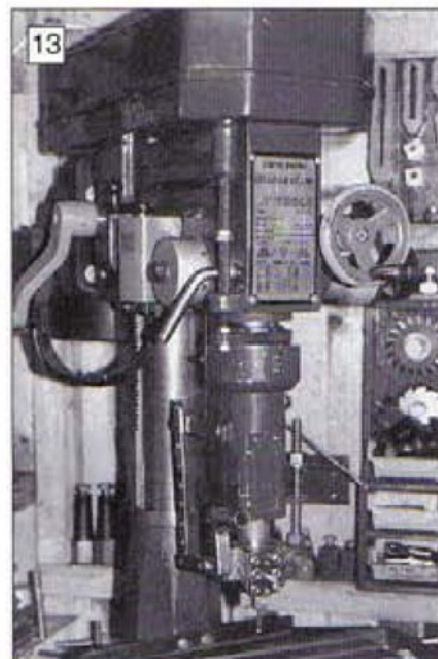
possible the holes can be spotted through with a pistol drill and dimpled with the unit removed. The unit should be able to be re-mounted correctly on every occasion in the future by simply tightening the three grub screws. By fitting the lever handle (Item 12), the ram can now be moved up and down with ease. This arrangement worked fine when cutting slots, but as an afterthought I fitted a horizontal support bar from the lower part of the main body to the column of the milling machine. This now made the set-up exceptionally rigid.

The Slotter In Use

In order to put the new attachment into use it will be necessary to have the appropriate cutting tools to fit it. Tools are easily made and are, once secured in the ram, very sturdy in operation. 16mm square mild steel bar is used for making the tool shanks, which are fitted with different sizes of HSS bits. These bits are simply constructed out of round section and held in the shank with a grub screw. **(Fig. 2).** An alternative design for the cutting tool is that which is shown in **Fig. 3**



Machining a spline in a gear wheel.



The completed attachment in position.

(tool 'B'). The HSS bit is fitted from the front of the shank on this type and it will be clear that its use is limited to the larger bores which will allow the shank to enter. The minimum diameter of bore in which this tool may be used will be in the region of 30mm and this equates to an 8mm wide keyway (BS 4235). I have cut 12mm keyways on this attachment although I confess to 'piloting' with a narrower tool first.

The hub which is to be provided with a keyway is securely clamped onto the table of the milling machine and the tool is centralised in the bore prior to the commencement of cutting. A very simple method of getting on centre is shown in

Fig. 3, where a small gap is left between the surface of the bore and the corner of the tool. The table is then moved to the left or right as a feeler gauge blade, say 0.25 mm, is slid into the gap until the two gaps are felt to be the same. The cutting tool is then on centre to a very acceptable degree of accuracy. It will also be seen from **Fig.3** that in order to enjoy any success from using this method, the tool will have to be ground precisely in that the front edge of the tool must be parallel with the back (seating) face of the shank. If this is not so, the tool will be off centre when the feeler gauge senses that the two gaps are equal. The tool should really be ground thus in any case, whatever method is used to centralise it.

When the hub is

centralised, the depth of the stroke can be set to clear the table by adjusting the depth stop. The work itself should be mounted on parallels to clear the table and allow the tool to exit the back of the bore. It also provides somewhere for the swarf to go. It is not advisable to rely upon one of the 'T'-slots in the table to provide clearance for the tool. If any movement of the table occurs when the work is clamped to it, the 'T'-slot will be 'blind' and, if accidentally brought under the tool, can be seriously damaged. Always set the depth stop short of the table and raise the work up to it (Fig. 5). The table is moved back towards the column until the tool corners just touch the bore of the hub and the lead screw dial can

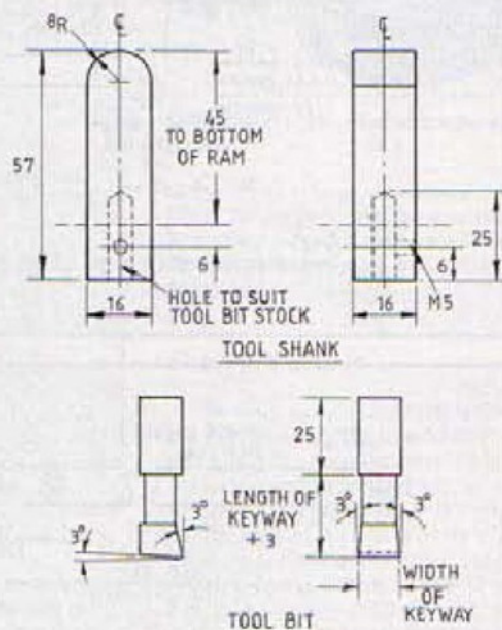


FIG. 2 TOOL SHANK AND TOOL BIT

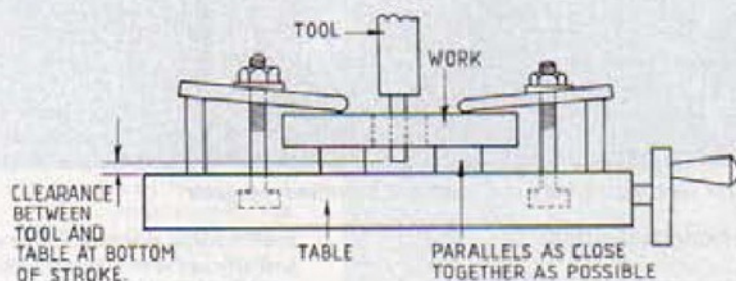
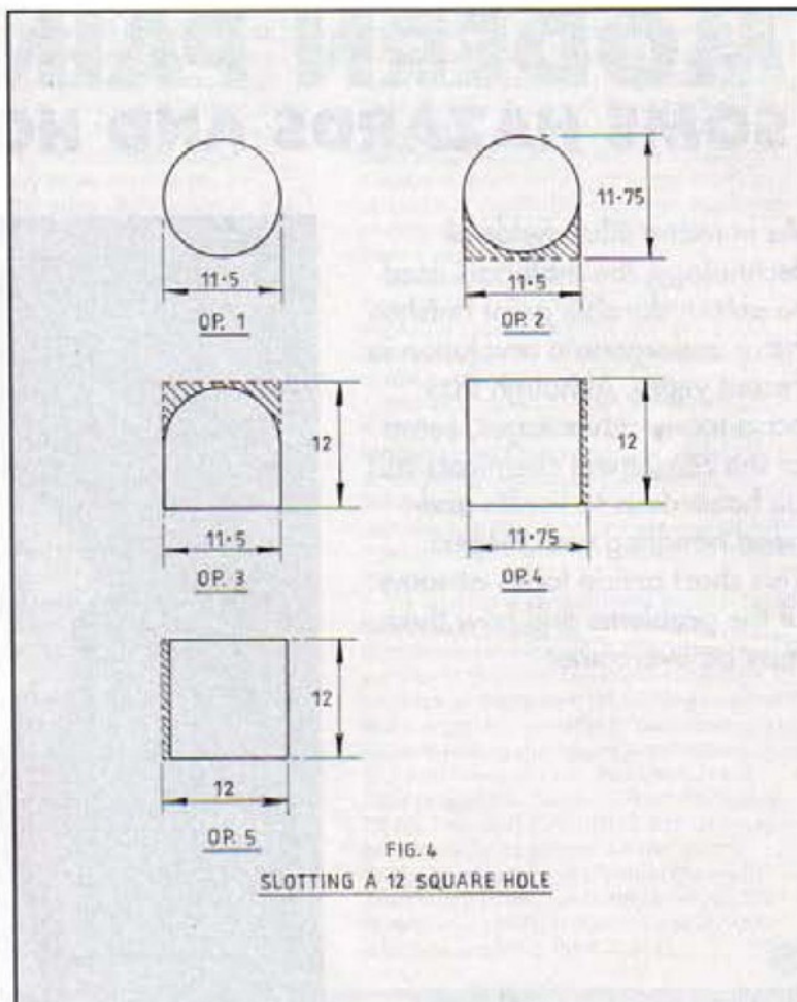
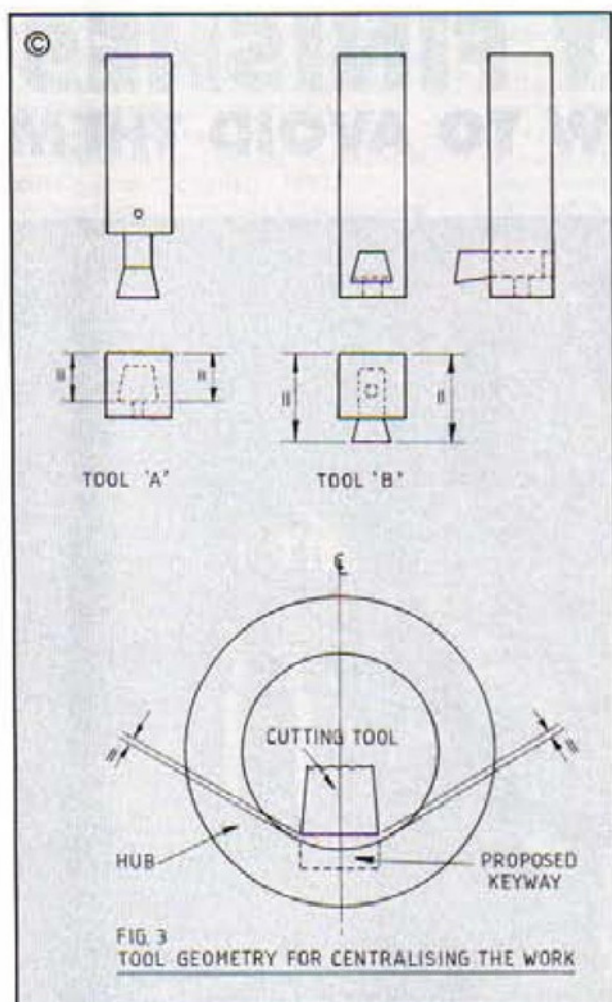


FIG. 5 THE SET UP ON THE MILLING TABLE

clamped to the milling machine table and the procedure described in **Figs. 4** employed. The example is the production of a 12mm square hole.

Operation 1 is to drill a hole which is slightly smaller than the finished square size. By using an undersized drill an extremely good quality hole can be achieved, but, of course, if a lesser quality hole is acceptable, a larger pilot hole can be drilled and just the corners removed by slotting, which makes the procedure a lot easier.

Op.2 shows the front of the hole slotted out to size, the sectioned area being the material which is to be removed.

Op.3 has the job with the back of the hole slotted out. To do this the tool is turned round in the ram through 180 degrees. Operations 4 & 5 require the tool to be turned through 90 degrees respectively to complete the hole.

Careful measurement will reward the craftsman with a perfect 12mm square hole.

A final point to prospective constructors of such a slotting attachment as is described here is the careful thought of which hand it should be. My example has the lever at the left of the body but many people prefer the lever to be to the right. It makes no difference to the efficiency of the contrivance which hand is chosen - it is merely a matter of preference.

be zeroed. The ram is now moved up and down by means of the lever handle and small cuts are taken until the required depth has been reached. Experience will decide the depth of cut per stroke and I can offer my usual cut of 0.01 mm as a good starting point. As the cuts are taken, cutting compound can be brushed onto the work to assist the operation. There is no doubt that this is of great benefit.

To obtain the correct depth of keyway for a given bore, tables can be used which are, in the first instance, to be found in BS. 46 or BS. 4235. Many reference books reiterate this valuable information and the accompanying article on keys and keyways includes tables of particular interest to the model engineer. A photo copy of such tables is enormously useful upon the workshop wall, alongside the tapping sizes

and decimal equivalent charts. When this correct depth has been achieved, it is as well to run the cutting tool up and down several times to let the cutter 'dwell'. This will ensure a good parallel keyway because of the fact that dwelling will remove metal from the extreme end of the slot where the tool may have deflected during the main cutting process. You should now have produced a keyway to a very high standard and without a great deal of trouble.

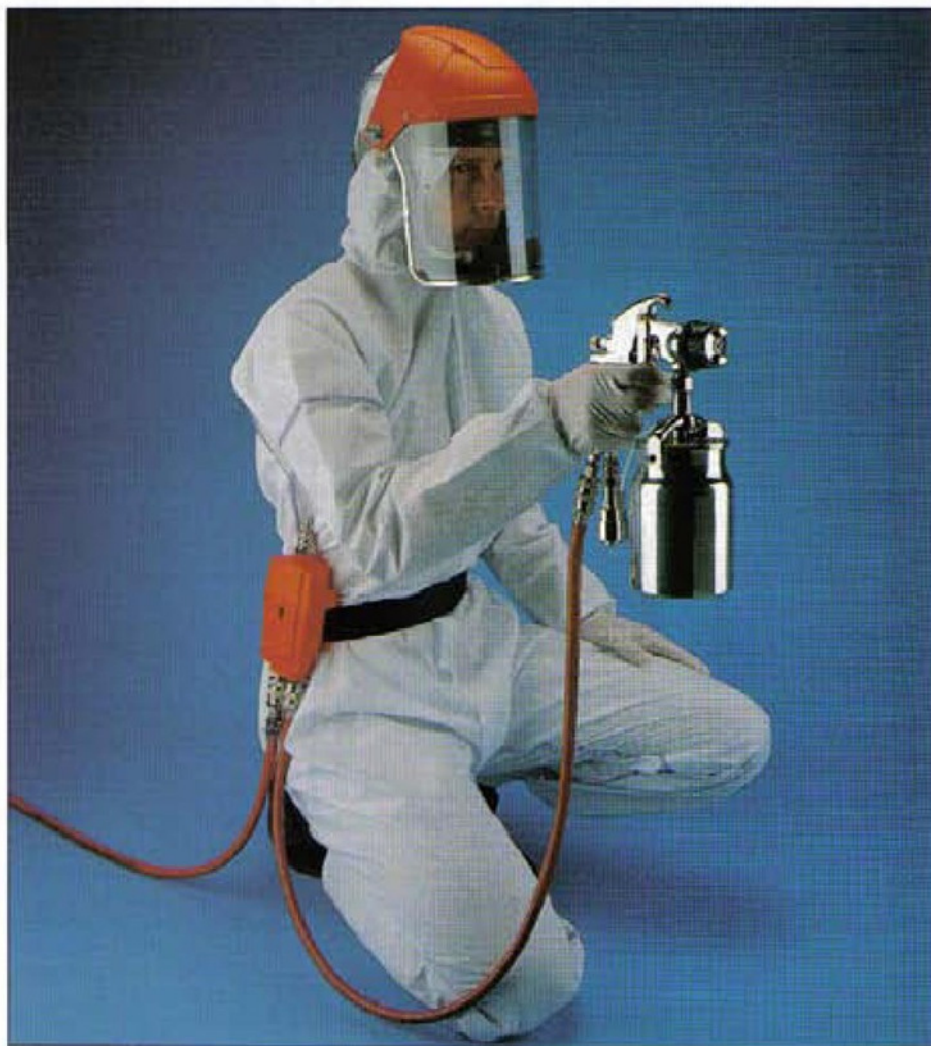
Square Holes

An additional feature of this slotting attachment is the useful ability to cut precise square (or rectangular) holes without the aid of an indexing fixture of any kind. The work remains simply

MODERN PAINT FINISHES

SOME HAZARDS AND HOW TO AVOID THEM

As in many other fields of technology, the materials used to obtain durable paint finishes have undergone a revolution in recent years. Although they have many advantages, some of the constituent chemicals can be hazardous to health and need handling with respect. This short article looks at some of the problems and how they may be overcome.



Sprayer wearing air-fed mask with belt mounted regulator

Many products of the home workshop, be they newly built scale models, refurbished stationary engines or restored vintage or classic vehicles usually require painting before they can be considered to be complete. Traditionally, this final finishing process involved painstaking work with slow drying materials applied by brush. With the increased availability of compressed air supplies in the private garage or workshop, many of our fraternity have been taking advantage of the faster drying characteristics of the materials used by the motor vehicle refinishing trade, such materials being easily obtained in a vast range of colours, or, if originality requires it, mixed to specification without too much difficulty. The base material most frequently used for this purpose has, for many years been nitro-cellulose (or just 'cellulose' as it is more commonly known). It has been the stock in trade of the small motor body repair shop, where we have all glimpsed, through an open door and a fog of overspray, the sprayer, perhaps wearing a cartridge filter mask, laying primer-surfacer or top coat onto a newly straightened wing.

The new materials

This scene is changing rapidly due to two inter-acting factors, firstly, the materials being used and secondly the allowable processes by which they may be applied. The search for more durable finishes encouraged by stiff competition in the offering of longer warranties, together with the demands of the stylists, who are ever seeking more exotic descriptions of their colours for the brochures, have led to the development of such paints as metallic and pearlescents in polyurethane and clear-over-base systems. These usually have two-pack components applied at some stage of the process and, more often than not, contain isocyanates such as toluene di-isocyanate (TDI) or di-phenyl methane di-isocyanate (MDI). These materials are lung irritants of such toxicity that inhalation of any appreciable quantity of their vapours can lead to severe respiratory problems. They are also sensitisers, in that conditions can arise where exposure to lower and lower doses can trigger the symptoms. People entering the refinishing trade are now advised to

seek medical examination at an early stage and anyone with susceptibility to respiratory problems is advised to follow another career path.

Isocyanate bearing compounds are widely available for purchase without restriction. Look on the label of any tin of polyurethane paint and it is likely that you will find a black cross on an orange background, with the legend 'Harmful', but how often are we offered the data sheet which the manufacturer is required to prepare under the Control Of Substances Hazardous to Health (COSHH) Regulations? Yet it is the potentially hazardous properties of these materials (as well as those of cellulose) which are causing a revolution in the plant, equipment and methods by which they may be applied.

Effects of legislation

The main thrust of the attack has been on the reduction of release to atmosphere of volatile organic compounds (VOCs). These break down under the photo-synthesis effects of sunlight to produce an

atmospheric haze which can develop into 'smog'. United Kingdom legislation is following the path set in the United States, where severe pollution in the densely populated areas of California has highlighted the need to reduce levels of VOC emission (now also attributed to the cooking of hamburgers!!). The Environmental Protection Act is requiring the problem to be tackled in a number of ways. Paint manufacturers are being required to reduce the VOC content of their products in accordance with a published timetable and users are required to reduce the levels of these pollutants which they release to atmosphere. Commercial organisations using significant amounts of solvent have been made subject to local authority control and, while the levels of use which entail registration are far above those likely to be experienced in our activities, it is the knock-on effects which could concern us. A severe reduction in the commercial use of those materials which we can handle reasonably safely without too much difficulty (e.g. cellulose) could result in their manufacture becoming uneconomic, or at best could push up the price significantly.

The new tools

On the equipment side, apart from the use of increasingly elaborate spray booths to contain potentially harmful emissions, there has been one significant development in recent times. From 1 October 1994 it has been a requirement that, for the application of all primers and commercial vehicle paints, High Volume, Low Pressure (HVL) spraying equipment shall be used. It is confidently predicted that this requirement will be extended to top coat materials in the not too distant future. Conventional spray guns were developed on the use of air at a delivery pressure at the gun of between 40 and 60 psi, a pressure range which would achieve the required droplet size and would also transfer these droplets over the recommended gun to work surface distance of 6 to 8 inches. Unfortunately, the residual energy in the droplets when they reach the surface is such that a high level of bounceback occurs, so that some of the paint does not adhere to the surface and other paint droplets are prevented from reaching their target. This amount can be as high as 65%, i.e. a transfer ratio as low as only 35%, with the remainder going to waste. Hence the fog frequently seen in the old jobbing spray shop.

HVL spraying equipment is, in principle, identical with high pressure equipment in that a compressor is used to deliver air to a spray gun which uses the energy contained in that air to atomise the paint and to transfer the droplets from the gun to the surface to be painted. The essential difference is that, in order to reduce the 'bounceback', it is necessary to reduce the speed at which the droplets arrive at the target surface. This requires the nozzle velocity to be lowered accordingly, which is achieved by dropping the nozzle air pressure to no more than 10 psi (0.7 Bar). This is brought about by some form of pressure regulating device within the gun, as the supply to the gun is still at the previous levels. In order to ensure that

the limiting nozzle pressure is not exceeded, the spray gun kit should include an additional air cap with pressure gauge attached, so that the supply air regulator can be adjusted to set the nozzle conditions in a positive manner. A penalty entailed in the use of this system is that a larger air compressor may be needed as the air demand is of the order of 25% higher (e.g. 17 cu.ft./min compared with 13.7 cu. ft./min). In operation, the gun must be held closer to the work surface, the recommended distance being not more than 6 inches, but a big advantage is that we should be wasting far less of our precious paint and perhaps be at less risk of annoying the neighbours.

HVL guns are now being listed by a number of our advertisers, so there should be no problems over availability.

Protection for the operator

On the personal protection front, isocyanate bearing materials should not be sprayed if only the conventional filter mask is available.

Even when using a full face canister respirator to BS2091: 1969, exposure should be limited to no more than 15 minutes, after which the filters should be changed. To use this type of paint safely, a sealed, full face mask to BS4667: Part 3: 1974 should be worn. A positive pressure clean air feed is essential as these masks operate at a pressure of 7 psi via a belt mounted regulator, which may also have provision for the gun air supply, thus only

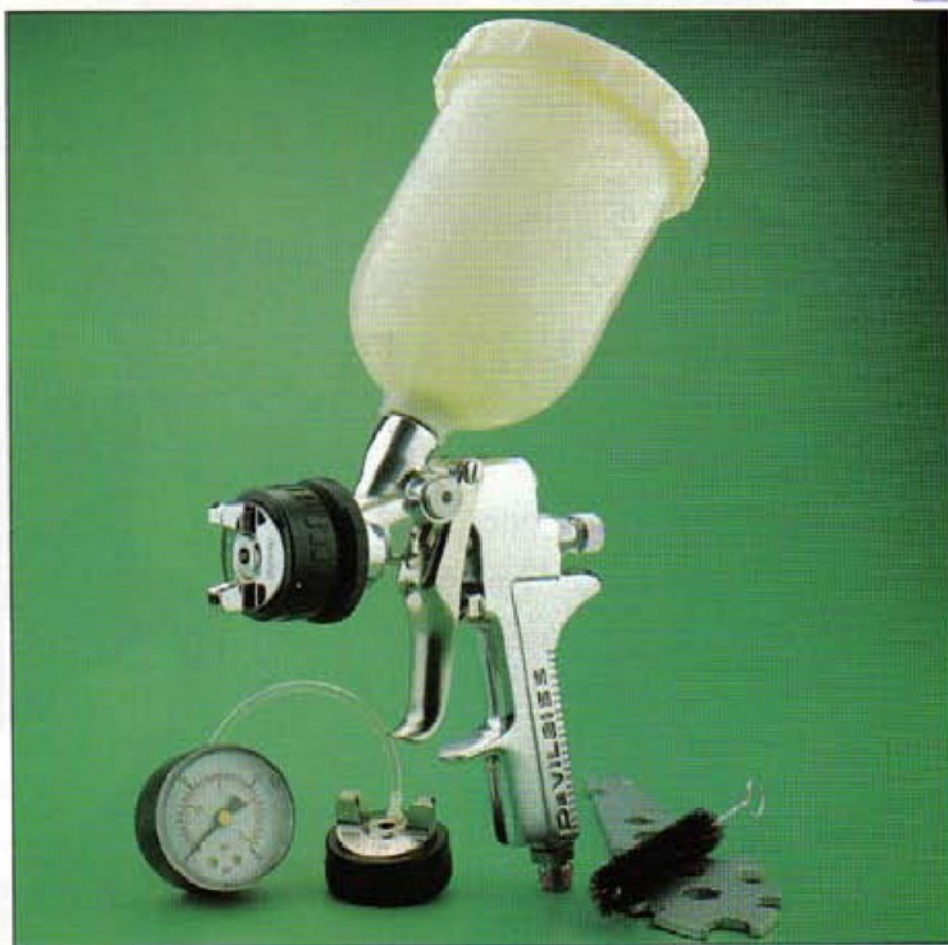
one air line is needed from the main compressor feed. The equipment used to supply this air should ideally be designed in accordance with the requirements of BS4275: 1974. It goes without saying that the air intake to the compressor which is supplying the mask should be outside the enclosure in which the spraying is being carried out. Again, the specialist suppliers among our advertisers will be able to advise you.

Isocyanates can also be absorbed through the skin, so if any prolonged exposure is anticipated, it is also a good idea to keep arms and hands covered and to use barrier creams.

Not only paints contain these harmful materials. Fillers and stoppers can also produce toxic fumes and dust especially when being sanded, so mechanical sanding devices which incorporate a vacuum extraction system are a great help. Again, protective clothing and dust masks are a must.

As so frequently seems to happen these days, new developments can bring significant advantages, but so often there is a down side which can cause problems. In the case of these new refinishing materials, there are many benefits to be gained, so by understanding the hazards and setting out to avoid them, we can make full use of their properties. The important thing is to READ THE INSTRUCTIONS and take heed of the warnings printed on the labels.

Excellent advice is given in the Health and Safety Executive publication HS(G)67 Health and safety in motor vehicle repair which is available from HMSO.



HVL spraygun, showing slave air cap fitted with pressure gauge. (Both photographs courtesy of the DeVilbiss Division of ITW Ltd.)

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The first is a steel workbench with a reversible plywood worktop. It has a steel drawer, lockable cabinet and shelves, and measures 1205 x 600 x 850mm (Length, width, height). It is priced at £57.95 + VAT.



To go with this is a wall mounted tool cabinet, again of steel and with lockable hinged doors. Dimensions are 1220 x 210 x 610mm and comes with four shelves and 24 assorted pegs/hooks. This retails at £44.95.

Four new items from Clarke Power Products

Clarks have been busy with the launch of four new products, two of which are workshop/garage furniture, and the others, new machines.



The smaller of the new machines is a Belt and Disc Sander. The belt is 4in. wide x 36in. and tilts and locks at any angle from 0 to 90deg., and the disc is 6in. diameter. A 0 to 45deg. tilting table is 220 x 155mm and the unit is driven by a 440 watt motor for use with woods, plastics and non-ferrous metals. RRP is £109.95 + VAT.



The major unit to be introduced is a lathe with mill/drill head attached. Listed as the CL500M, it features a six speed lathe of 305mm swing over bed and a twelve speed head with 13mm drilling capacity. Price is £769.95 + VAT. Clarke International Tel. 0181 986 8231

New Catalogues

R.S. Components/Electromail

The 1995 Edition No.2 of the RS Mechanical catalogue is now available. This now lists around 17,000 ex-stock industrial parts, materials and supplies — an increase of 1000 products compared with the previous issue.

Although RS themselves work through an account system, which is intended primarily for industrial customers, the same products are available on a retail basis from Electromail.

RS Components Ltd., PO Box 99 Corby, Northants, NN17 9RS. Tel.. 01 536 201234

Electromail, PO Box 33, Corby, Northants, NN17 9EL Tel.. 01 563 204555

Inter City Machine Tools

InterCity Machine Tools of High Wycombe have also published their new catalogue of new and used equipment. It covers machine tools, sheet metal machines and small tools and equipment. They make a particular point of their policy of catering for the model engineer and of their demonstration of Transwave phase converters, as shown on their stand at the recent International Model Engineer and Modelling Exhibition at Olympia.

InterCity Machine Tools (High Wycombe) Ltd. Lindsay Avenue, High Wycombe, Bucks, HP12 3ER. Tel.. 01 494 533211-2-3 Fax 01 494 531602

New Drilling Machines from Meddings

In response to the market demand for economy drilling equipment, Meddings have introduced new 13mm and 16mm capacity bench and floor mounted drills in their Popular range. Three models are available, a 13mm bench unit, with five speeds and 16mm bench and floor drills, both with twelve speeds. They are fitted with motors operating from a standard 240V AC 50Hz single phase supply and have a no-volt starter, cut-out micro-switch under the belt cover and a drill guard. Prices start at around £200.

Meddings Machine Tools Ltd., Lee Mill Industrial Estate, Ivybridge, Devon, PL21 9LL. Tel. 01752 893277. Fax. 01752 690447.

A new approach to small part storage

The Caretaker is a new carousel type storage unit for small items. Nine removable pots are mounted in each disc, with the possibility of accommodating twelve discs on the two metre high system. An alternative bench mounted system holds four discs. If the open pots are not to your liking, then the discs will accept standard 454 gram jars, ex the kitchen.

For further information contact :Caretaker Storage Systems 22 Dewlands Road, Verwood, Dorset



A SMALL DIVIDING HEAD

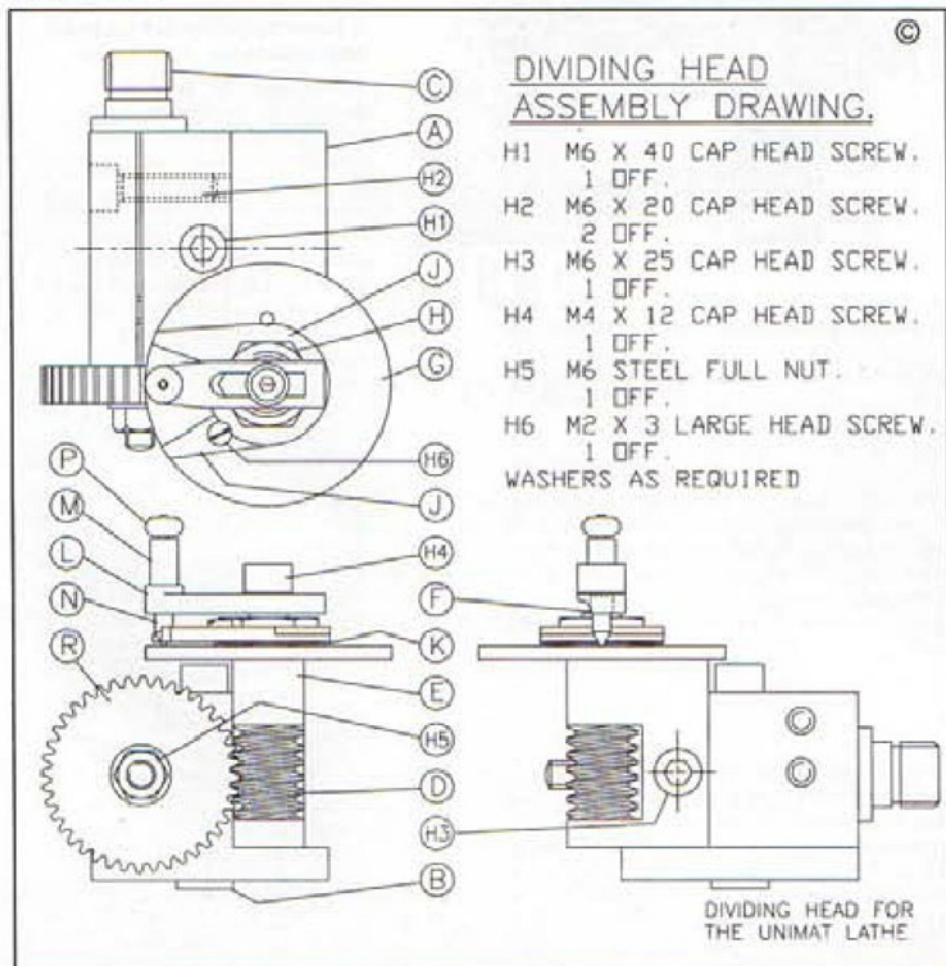
Mr. T. Taylor of Namibia provides a design for a small dividing head. It is used on his Unimat, but is in no way limited to that lathe, or even that size of lathe.

This dividing head was made when I became interested in gear cutting, with the idea of eventually making a clock. This project never materialised. However, I have successfully cut several gears. A dividing head is available for the Unimat lathe but, as this is the direct dividing type, its usefulness is limited. Although the tool described here has been made for use on the Unimat, it can be used on other lathes. I have used it on the Unimat's big brother, the Maximat VIO.

I am not an experienced engineer, or metal turner, and the fact that I was able to successfully complete this project, should encourage those similarly inexperienced. There is no complicated machining and most can be done on the Unimat itself, although a larger machine will make the work easier. Only a few of the dimensions are critical so feel free to make changes to suit your need.



1: The parts, less division plates, ready for assembly. My method of locating the gear on the mandrel is different to that drawn, hence the collar at the bottom of the picture and no pins in the mandrels.

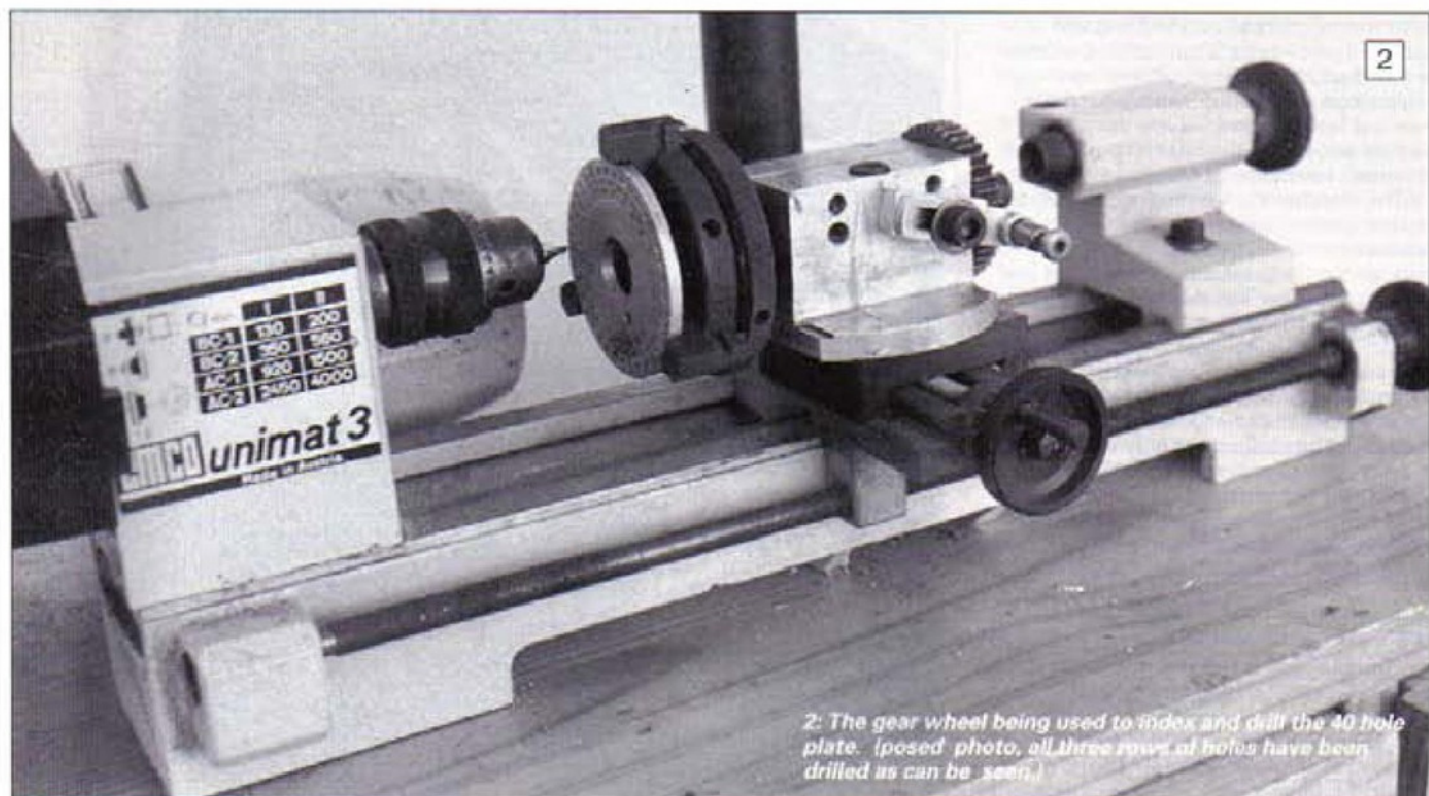


Main assembly

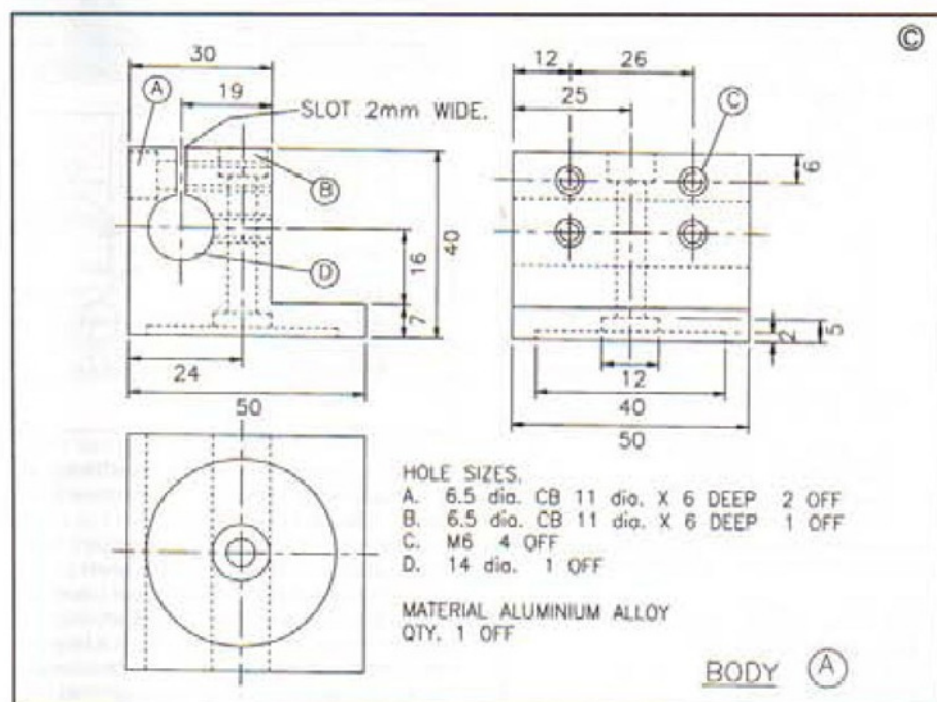
The body (A) is cut from a 50 x 50 x 40mm block of aluminium alloy. I cut mine from a block of metal formed by pouring molten motor car pistons into an empty jam tin. This is easily machined and, if facilities for melting the pistons are available, is a cheap and readily available raw material. I appreciate that not everyone will have such facilities, so a piece from an aluminium alloy bar could be used. The curved edges, seen in **photo 1**, are a result of the parts being cut from the round block. The drawings show the edges square.

The body was cleaned up in the four jaw chuck, but if only the Unimat is available, remember it is a heavy and unbalanced piece of metal and the slowest speed and lightest of cuts are essential. The only critical measurement is the 19mm dimension. It may be advisable to leave the final machining of this side until the worm and worm carrier have been made.

The hole for the mounting screw should be drilled while the body is still in the four jaw chuck, and it should be positioned in the chuck with this operation in mind. Make also the 2mm deep recess and the counter bore for the locating collar (B). This collar, which fits into the recess in the Unimat's cross slide, is a straight forward



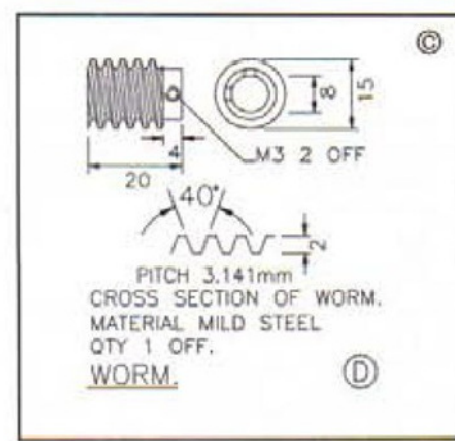
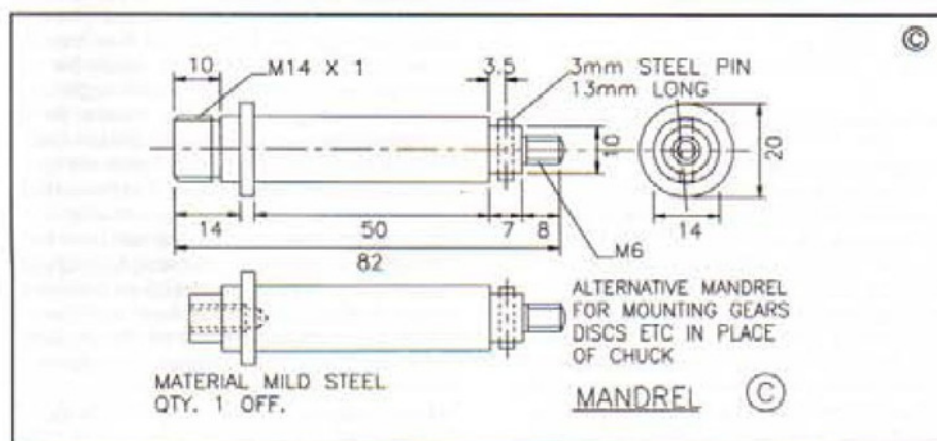
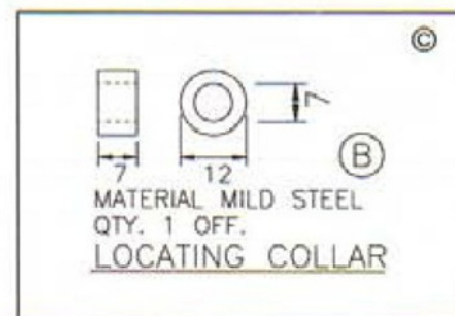
2: The gear wheel being used to index and drill the 40 hole plate. (posed photo, all three rows of holes have been drilled as can be seen.)



turning operation, and is made a press fit, or fixed with a suitable adhesive.

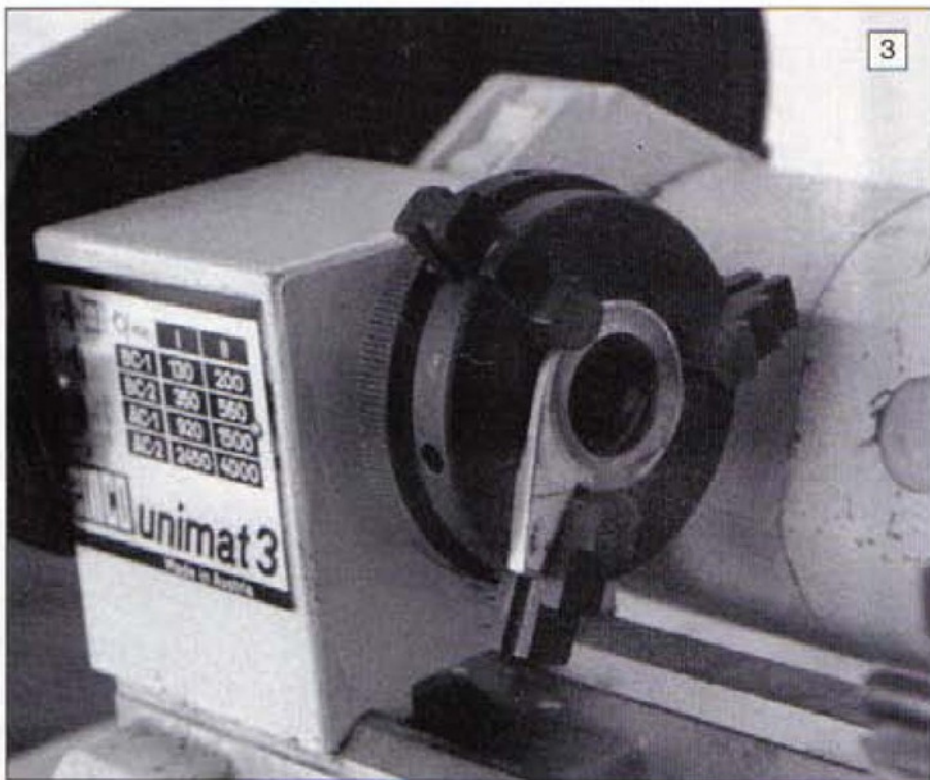
It is preferable that the mandrel (C) is on the centre line of the lathe and, for this reason, the hole for this should be made with a boring bar between centres. The hole for the fixing screw, having been drilled, is now used to bolt the body to the cross slide. With the block mounted and aligned, the hole can be started, say with a 6mm drill, and enlarged until a suitably sized boring bar can be used.

If you were unable to clean up all sides of the body in the four jaw chuck you can now do so using a suitable end mill. As the

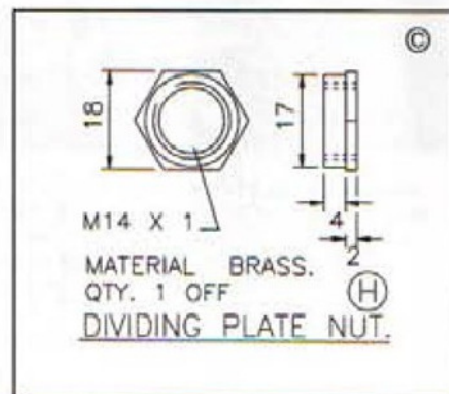
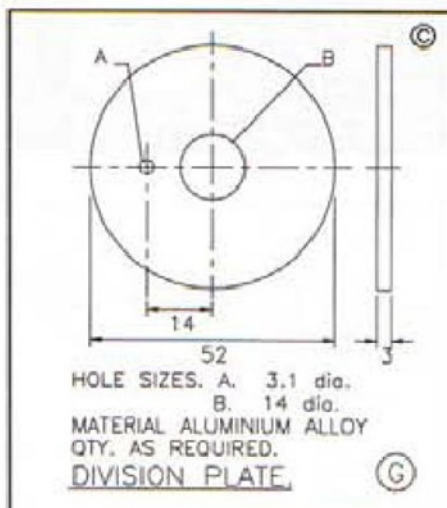
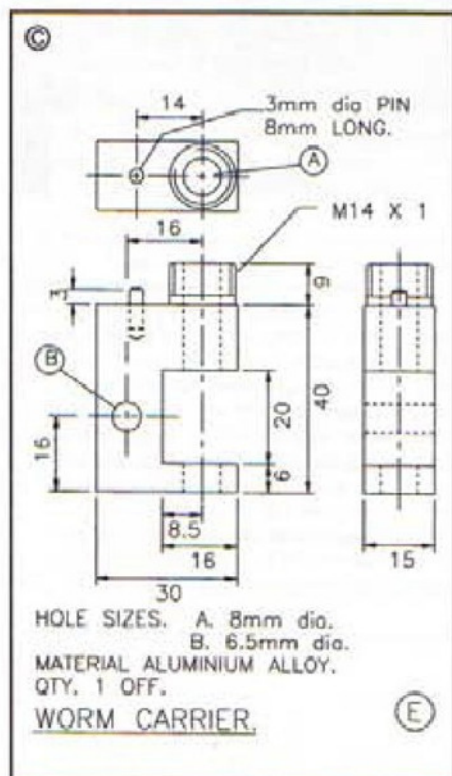


sides are not critical, careful filing will suffice. If you have a larger lathe, the ends of the block can be faced off leaving a slight ridge about 6mm wide around the mandrel bore. This will space the gear slightly away from the base to provide for smoother operation.

The mandrel (C) is a turning job and, to ensure concentricity, this should be turned between centres. The portion that goes through the body must be a smooth fit without any play. The clamping screws are to clamp the mandrel not to take up play. As an alternative, the mandrel can be simplified by using a plain length of bright mild steel with the collar at the chuck end made a press fit or fixed using a suitable adhesive. The diameter could be enlarged to say 15mm to provide a shoulder for the collar to be tightened against. The nose is turned and threaded to take the lathe chuck, which for the Unimat is M14 x 1mm. The other end is turned to fit the gear



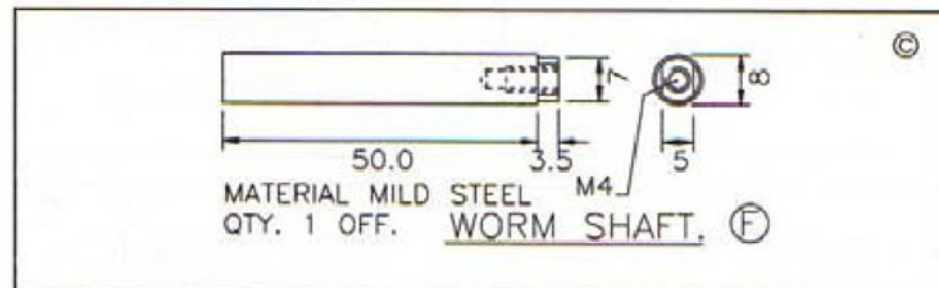
3: Division finger in three jaw chuck to recess centre.



may find it preferable to adopt another, I did, which is the reason for the differences seen in **photo 1**. The essential requirement is that the gear must be solidly attached to the mandrel shaft.

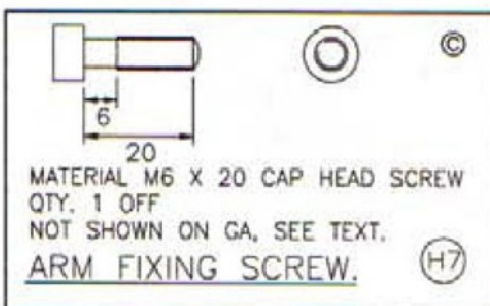
As it is impossible to hold gear blanks, in the chuck, except for small gears and pinions which can be parted from a larger bar; a special mandrel was made especially for cutting gears. This is shown on the drawing with the chuck holding mandrel. Turn the nose to suit the gears that you are likely to be cutting. Although this is then limited to gears with this bore, it can be adapted by the use of bushes for larger bores, or extension pieces for smaller ones.

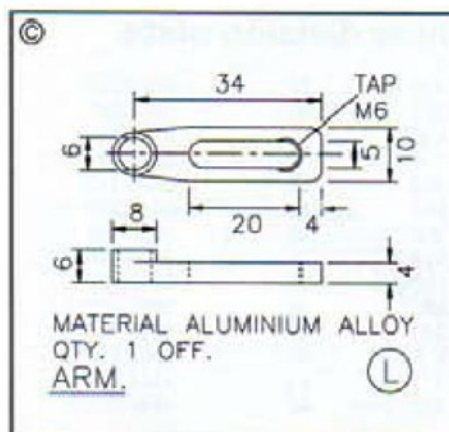
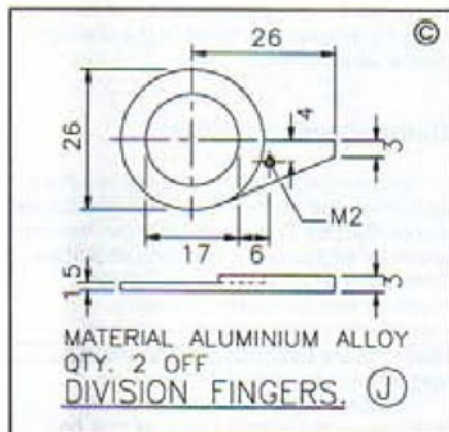
Assemble the mandrel and gear to the body to ensure that the shaft turns easily, and without any play, adjust if necessary. If all is in order take it apart again. The holes for the clamping screws can now be drilled and tapped M6, followed by making the slit. I used cap head screws as I wanted to standardise the dividing head with the rest of the clamping screws on the Unimat. If you use hexagon head bolts I would recommend that washers be used between the bolt heads and the body to reduce wear.



wheel that you will be using.

It may be a good time to discuss the gear wheel (R). Commercial worm wheels and worms are available and can be used, but one can use a standard lathe change wheel as I did. The gear is a 40 tooth at 1 module pitch, i.e. 1 tooth for every 1mm of the pitch diameter. Anything larger will foul the cross slide which is only around 23mm below centre line. The gear that you use will determine how it should be fitted. The drawings show one approach, but you



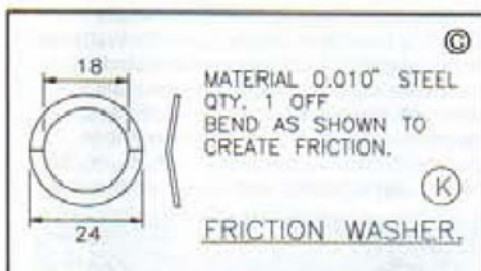


QUICK TIP

'O' rings

A useful source of very small 'O' rings is the disposable gas lighter (empty!). Often two or three can be extracted.

G Hugh Dawkins



the cut out for the worm is made, as it may be a problem at a later stage to hold the carrier in the four jaw chuck of the smaller lathes. To locate the dividing disks a 3mm diameter pin is fixed to the worm carrier as shown. It must not project by more than the thickness of the dividing plate to avoid interfering with the division fingers. It may be advisable to wait until the dividing disks are made and spot the position of the pin from these.

The worm shaft (F) is a turning and filing job from a length of 8mm mild steel. The shaft is reduced to 7mm at the top before the flats for the dividing arm are filed or milled. The reason for reduction to 7mm is to allow a washer having a 7mm hole to take the strain of the clamping screw and not the relatively narrow shoulders of the two flats. Finally, the end is tapped M4 for the fixing screw, also two flats positioned for the worm holding grub screws. To standardise the fixing screws, I turned an M6 cap head screw down to M4 so that a standard M6 cap key could be used throughout.

The worm carrier assembly can now be assembled and tested. There should be no vertical play of the worm in the carrier. If there is, this can be taken up with shim washers. Try the assembly to the body and see how the worm engages with the gear, tilting slightly if necessary for the helix angle. We purposely left the final machining of face to ensure a perfect fit with the worm which must now be done.

Lazy man's hint

Take off slightly more than is necessary and adjust with shims. This has the advantage that wear can at a later stage be taken up by removing or altering shims.

The position of the fixing screw can be spotted and drilled and tapped into the body. To avoid later problems this fixing screw is on the centre line of the mandrel. I did not think this far ahead which accounts for the angle of the indexing arm shown in **photo 2**. Provision is made for fixing screws at both ends of the body as this permits the mandrel and carrier to be fitted at either end, depending on which is most convenient. (Compare **photo 4** with the G.A.).

Once everything is correctly set up and turns smoothly without any play, two 3mm dowel pins could be fitted at each end, between carrier and body, to aid accurate reassembly in the mode being used. The holes in the carrier can be opened out slightly after the pins, which must be a

tight fit in the body, are fitted. These locating pins are not shown on the drawings, or seen in the photographs.

Division plates (G) are simply cut from 3mm aluminium using a hole saw and cleaned up on the lathe. The centre hole and the pin hole are bored to suit the worm carrier. It may be thought that 3mm is too thick, however, this has the advantage that blind holes can be drilled from both sides. I was able to drill three rows of holes each side giving six in total for each disk. The suggested divisions are 27, 33, 34, 36, 38, 39, 40 and 42. This will give most numbers that will be needed. Other numbers can be produced to suit individual needs. With two plates there is space for 12 rows leaving 4 rows available for other numbers. I will explain later how these plates are drilled.

The dividing plate nut (H) is turned from brass hexagon bar. Alternatively, round bar 20mm diameter could be used and the top knurled. There should be no problem in turning this item to screw on the top of the worm carrier to hold the division plate. The straight section forms the boss around which the division fingers rotate.

Two division fingers (J) are cut from 3mm aluminium, most of the shaping being done by hand. The shape is cut roughly to size and then mounted in the three jaw chuck for boring the centre hole and to reduce the thickness around the hole by half. It may seem impossible to mount such an odd shaped piece in the chuck, but if the finger is located against the one jaw there will be no problem. See **photo 3**.

The centre is bored for an easy fit on the dividing plate nut. Without taking the finger from the lathe, the portion around the hole is reduced to 1.5mm thick. By purposely cutting these oversize there should be no danger of hitting the chuck jaws in this operation. The 1.5mm must be on the full side, so that when the two fingers are placed on each other, the upper finger stands slightly proud of the lower finger. This enables the head of the locking screw to clamp the two halves together.

Now comes the hard part of filing the fingers by hand to their final size. It is advisable to do both parts at the same time, checking constantly to ensure that the two parts dovetail neatly together. The reduced section is a good guide to the filing as the material surrounding this must be just filed away. When assembled the fingers should open to more than 180 deg.

A small M2 screw fitted in a tapped hole in the lower of the two fingers is to clamp the two halves together. This screw should have a large head to overlap the joint, alternatively a small washer can be used to bridge the gap.

Friction washer (K) remains to complete this section of the dividing head. Cut this from a piece of 10 thou. steel, and by kinking the washer sufficient friction is created to hold the fingers in place between moves. The dividing arm assembly

The dividing arm, is made from 5 pieces, the arm (L), barrel (M), plunger (N), knob (P) and the spring. The arm is from a piece of 10 x 6mm aluminium. Clamp this in the four jaw chuck and turn down to 4mm thick, creating at the same time the 8mm boss at one end. The hole for the barrel is drilled at the same time. After

The worm and dividing plate assembly

The worm (D) was turned from mild steel at 1 module (3.141mm) pitch. Check with your manual to see what change gears must be used to get this pitch. In the absence of this information, try cutting at $\frac{1}{16}$ in. pitch. This works out at 3.175mm which is only 0.034mm or 0.0013in. more than needed. I have not tried this, but feel the error is so negligible as not to be worth worrying about. Most spur gears are cut with a 20 deg. pressure angle, and the worm must be cut at this angle. To do this a thread cutting tool must be ground to an included angle of 40 deg. The depth of the teeth should be 2mm or slightly more. See drawing for shape of the thread. I suggest that the worm be meshed from time to time with the gear during this operation to check for a good fit. Note that if you are using a spur and not a proper worm gear, the gear will mesh at a slight angle due to the helix angle of the worm. The worm is bored for the worm shaft (F), turned down at one end for the M3 grub screw, and parted off to length.

The worm carrier (E) is cut from a piece of aluminium alloy. It may be easier to turn and thread the top to M14 x 1mm before

Calculator readings for 42 hole division plate

1	101.095	15	1516.428	29	2931.761
2	202.190	16	1617.523	30	3032.857
3	303.285	17	1718.619	31	3133.952
4	404.380	18	1819.714	32	3235.047 *
5	505.476	19	1920.869	33	3336.142
6	606.571	20	2021.904	34	3437.238
7	707.666	21	2122.999	35	3538.333
8	808.761	22	2224.095 *	36	3639.428
9	909.857	23	2325.190	37	3740.523
10	1010.952	24	2426.285	38	3841.619
11	1112.047 *	25	2527.380	39	3942.714
12	1213.142	26	2628.476	40	4043.809
13	1314.238	27	2729.571	41	4144.904
14	1415.333	28	2830.666	42	4246.000 *

Note: Although only 3 decimal places are shown, the calculator was working on the full 8 decimal places.

QUICK TIP

Tapping compound alternative

If you are out of tapping compound, ordinary household soap will work quite well. Indeed, it is better than lubricating oil.

Alan Jeeves

removal from the chuck the lower part of the boss is filed by hand, and the sides tapered to blend in.

Before cutting the slot, make the M6 hole at the end of the slot. This permits the arm fixing screw (H7) to enter the slot for fixing the arm as in **photo 2**, not shown on general arrangement drawing. The slot can be cut with an end mill or by drilling

and filing. The choice is yours. Check that the arm can move easily on the flats on the end of the worm shaft.

The barrel (M), plunger (N) and knob (P) are simple turning jobs. The plunger must be turned to be a smooth sliding fit in the barrel and without play. All that remains is a small compression spring. This can be either a commercial item or wound on the lathe. If I remember rightly I used a spring from a discarded ball point pen.

After assembly the arm can be tried on the worm carrier. The washer that goes onto the worm spindle prior to the arm being fitted must be a close fit on the 7mm dia. If you do not have a suitable washer now is the time to make one. As stated previously I turned and threaded an M6 cap screw to M4 to standardise on a 5mm cap key for all clamping screws.

Once assembled the arm should rotate smoothly and with the plunger retracted the division fingers should be cleared easily. There should however be sufficient

movement in the plunger to enter and securely engage the holes in the division plates when drilled.

Direct dividing facility

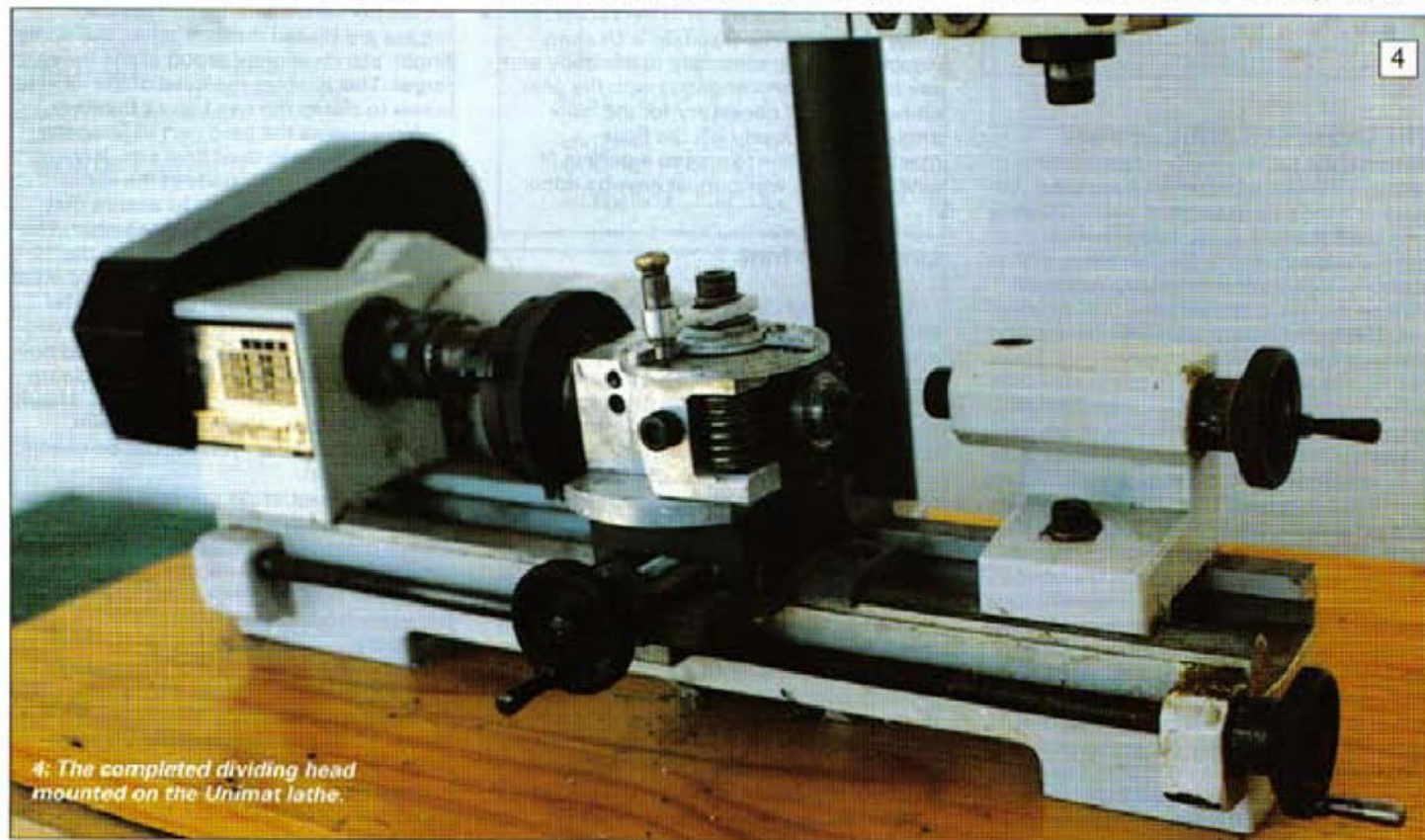
Only two additional parts are required to convert the indirect dividing head to use direct dividing. Drawings for these are not given as details in the text should suffice. Although not so accurate as indirect dividing, this is quicker and more convenient when a small number of divisions are required, such as drilling screw holes for cylinder covers etc.

The gear wheel is replaced for this purpose with a aluminium disk that has three rows of holes drilled on its edge. These contain 24, 30 and 36 holes. The 40 tooth gear is used for 40 divisions. The disk is 42mm in diameter and 10mm thick. The centre is drilled and cut as the gear wheel that it replaces and is fixed in the same way. The holes will be drilled at a later stage once the division plates are made.

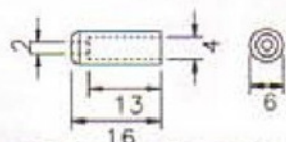
The dividing arm is mounted in place of the worm carrier using the modified screw (H7). A 6mm thick spacer raises the arm sufficiently to allow the plunger to engage the required row of holes. This spacer is just a strip of 10 x 6mm aluminium bar drilled 6mm in the centre, seen loose in **photo 1** and fitted in **photo 2**.

Drilling the division plates

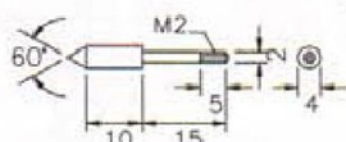
This operation requires the use of a dividing head and if one is available please make use of it. I will assume that such is not, otherwise you would not be making this one. We have completed sufficient parts to drill the required holes without problem. I would suggest 27, 33, 34, 36, 38, 39, 40 and 42 holes, and although these



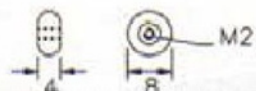
4: The completed dividing head mounted on the Unimat lathe.



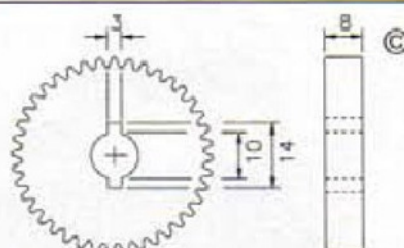
MATERIAL MILD STEEL
QTY. 1 OFF
BARREL (M)



MATERIAL MILD STEEL
QTY. 1 OFF
PLUNGER (N)



MATERIAL MILD STEEL
QTY. 1 OFF
KNOB (P)



MATERIAL WORM OR SPUR GEAR
40 TOOTH X 1 MOD.
QTY. 1 OFF.
GEAR (R)

will not give all possible divisions, it will cover the most common and several uncommon numbers.

Before we start with the more complex method we can produce a plate with 40 holes by direct dividing off the 40 tooth gear. The dividing head, fitted with three jaw chuck, is fastened to the cross slide with the chuck facing the headstock. Ensure that the mandrel is parallel with the centre line of the lathe. Mount the division plate blank in the chuck and fix the drill chuck in the headstock with a No. 2 centre drill. By indexing every tooth of the gear, 40 holes can be drilled in the first plate. This circle of holes should be approximately 2mm from the edge of the plate and 2mm deep. **Photo 2** shows the method but was taken after the plate had been fully drilled.

As almost 300 holes will have to be drilled, time can be saved by arranging for the lead-screw handle to be in a distinct position, say, at the top or bottom position, when the holes are deep enough. This way, depth can be judged by feel, instead of having to concentrate on the graduations on the handle itself.

As direct dividing is not as positive as dividing with the worm gear, make sure slack is taken up each time in the same direction before the mandrel is locked. Ensure also that the chuck is tightened on the mandrel nose, as any unwanted movement will ruin the dividing plate. With the 40 hole row completed we can tackle the others. This plate is now fastened to the worm carrier and the head assembled for indirect dividing, as in **photo 4**.

A few calculations

Before going further, some mathematics. With the 40 hole plate and the 40 tooth gear, one revolution of the mandrel will transverse 1600 holes (40 x 40). Taking the 42 hole plate as the next to be drilled, it means that for each space between holes the arm must pass 1600/42

or 38.095 holes. As we cannot divide between holes we will use 38 holes and make up the difference between 1596 holes (38 x 42) and 1600 holes, by using 39 holes in some places.

It may be remarked, and correctly so, that the final dividing plate will not be 100% accurate. If we consider the error it will be clear that this is so negligible as to be ignored. The error between adjacent holes will be at the most, 1 space on the 40 hole plate divided by 40, the number of teeth on the gear, or 0.225 deg.. When in use this error is further reduced by 40 i.e., an error of 0.0056 deg.. (For those not familiar with the workings of a gear driven dividing device, it should be understood, that in use, any error in a dividing plate is reduced by a factor equal to the number of teeth on the gear. Ed.) This represents an error of 0.0036mm (0.00014in.) on the circumference of a 75mm circle, about the maximum that the Unimat can handle.

There are many ways to calculate and drill the division plates and the method given may not be the best, but it works. For this we need a calculator. Enter 1600 (i.e., 40 x 40) and divide this with the number required (in this case 42). The answer will be 38.095238. If your calculator has more or less than 8 figures the answer will be slightly different. It is clear that we must index 38 and a bit holes. To keep track of how many holes have been drilled and when additional holes must be added, we subtract the whole number (38) and add on 101, this gives 101.095238. (if your calculator has 10 figures 1001 can be added instead of 101). As each hole is drilled, multiply this number by the number of holes drilled. The first figure (or two figures after the ninth hole) gives the number of holes after the first, while the last two figures before the decimal point will indicate when the extra hole must be added. The Table gives the readings that I got, only 3 decimal places are shown, to save space, although the calculator was calculating to 8 decimal places. It can be seen that the two figures before the

QUICK TIP

Protecting leadscrews

A spiral plastic garden plant stem protector makes a good telescopic guard for lead and feed shafts of a lathe.

Hugh McNair

decimal increases by 1 for positions 1 to 10, however at position 11 the increase is 2, similarly at positions 22, 32, 42. It is at these points that the extra hole is taken, i.e., 39 holes on the 40 hole plate is skipped instead of 38. Although the table shows that an extra hole must be taken at position 42, in practice position 42 will bring you back to the first hole.

Drilling the plates

As the division fingers cannot be opened to 38 we will have to set the dividing head up to take one turn less 2 holes, i.e., we set the fingers to 3 holes and turn it anti-clockwise as the arm is turned clockwise.

So far so good, we have now finished two sets of divisions. Only 6 to go. The next logical one would be the 39 hole division. This is now drilled at the back of the 42 holes just completed. Remember we only drilled the previous holes 2mm deep in the 3mm plate. It is unlikely that any of the holes will break through to those already drilled but if so no harm will be done. You can proceed as for the 42 hole ring but the 39 holes ring is in fact easier. 1600 divided by 39 = 41.025641 and 41 times 39 equals 1599 i.e., only one hole short of 1600. Set the division fingers to 2 holes and divide with one turn plus one hole. The extra hole will take care of itself when the last hole is drilled.

Continue with the remaining 5 rows 3mm apart, say 42, 38 and 33 holes on one plate with 39, 34 and 27 on the reverse, finally 40 and 36 on the other disk.

Remember when drilling the second row of holes on the plate with 40 holes you will have to use the 42 hole and the formula will be 42 x 40 divided by the number required.

All that remains is to drill the disk for direct dividing with rows of 24, 30 and 36 holes. These can be achieved using the 36 hole division plate, using 1 turn plus 24 holes, 1 turn plus 12 holes and 1 turn plus 4 holes respectively. As you will be drilling on the circumference of the disk, it cannot be held in the three jaw chuck. You can either use a short stub arbour fixed in the chuck or the alternate gear cutting mandrel, if made. Whichever is used, make sure that there is no possibility of movement during the drilling operation.

Last, but by no means least, do not be lazy as I am. Stamp or engrave on the various dividing plates the number of holes in each. If you do not you will have to count the holes each time that you use the dividing head.

This completes the dividing head and I trust that you will have as much pleasure in building, and using it as I have had.

A PAIR OF FLY CUTTERS

Having given up the editorial chair, Harold Hall has been able to spend more time in the workshop and has come up with this economical pair of flycutters, the larger of which has potential for further development

Probably one of the most common forms of milling cutter to be found in the home machine shop is the fly cutter. The reason being, no doubt, is its ability to be made, rather than purchased. If used in the lathe then it can be of the simplest form, that is a rectangular block drilled to take a round piece of tool steel and held in the four jaw chuck. In this form the ability to adjust the position of the block in the chuck makes it possible, in some cases, to double as a simple boring tool. In this brief article two conventional fly cutters (**photo 1**) are described, one for mounting into a Morse taper, the other into an endmill chuck or, alternatively, the four jaw chuck if used on the lathe.

Small fly cutter

This is very straightforward to make and very little is required to be said regarding its manufacture. First chuck a suitable length, around 2½ in. of 1 in. dia. mild steel and turn the shank. If it is to be used in a milling chuck the diameter is important and should be a close fit, hence the quoted dimension of 0.499 in., otherwise it is less critical. Follow this by making the thread, if it is intended that it will be used in an milling chuck, if not, then a plain parallel shank will suffice.

Remove from the chuck, turn round and grip carefully on the shank. Face the end and with the top slide set to 45 deg., produce the large chamfer. With the holder held on its shank, it will be possible to skim over the outer diameter. This serves no purpose other than to improve appearance, but is worth doing as it takes very little time and gives the holder a professional look.

With the turning complete, it remains to drill for the cutter and then its fixing screw. Set a tilting vice to 45 deg. and mount the holder as shown in **photo 2**, note the small Vee block under the shank, which makes the positioning much easier and more secure. First centre drill, then drill and ream ⅜ in. diameter to take the cutter,

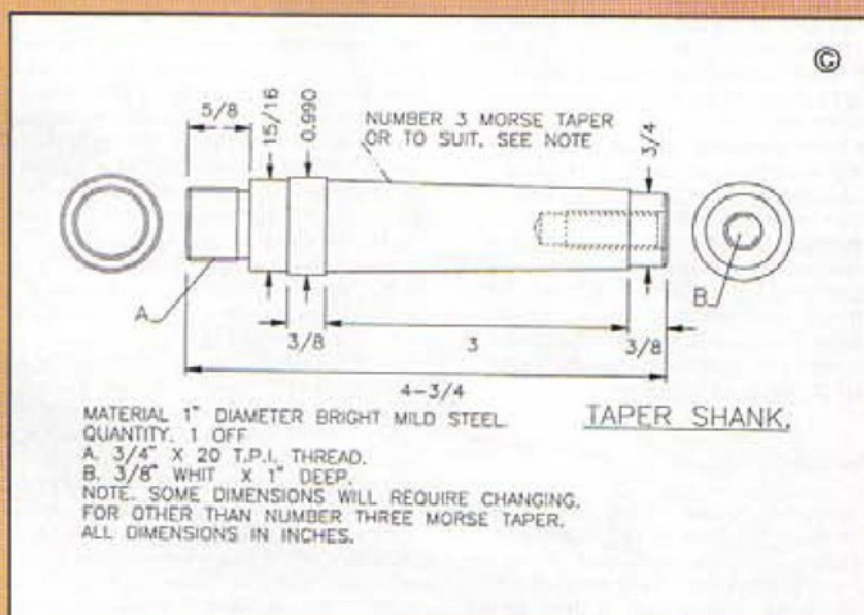


C1: The two completed fly cutters.

It now remains to drill and tap for the cutter fixing screw. This will be easier if a recess is made, as shown in **photo 6**, for the larger holder, though in the case of the small holder a single screw only is required. Turn the holder in the vice as seen in **photo 3**, again using the small Vee block to aid positioning. The drill placed in the cutter hole should be set to run parallel with the length of the table before the vice is tightened. Mill the recess, followed by a centre drill and finally a drill of size suitable for tapping M3.

Large fly cutter

The large cutter is made from two parts, as seen in **photo 4**. Making it from one piece would be quite practicable, though it would require a considerable amount of metal to be removed. Even so, it should still be quicker than making it from two parts as detailed. On the other hand, cost, if made from two pieces, would be a little cheaper, but probably not sufficient to justify this approach. The reason for constructing it with a removable shank was



that, at a latter date, the shank could be used to carry a small boring head. No doubt other uses will materialise in due course. Any reader who did not consider using the shank for other uses a possibility, could construct the parts with plain turned portions instead of the thread. These could then be joined using a suitable adhesive, typically a two part resin. This would then be economical both in time and money.

Take a length of 1in. diameter mild steel about 5in. long and mount this in the three jaw chuck. Support the outer end using a fixed steady and centre drill, remove the steady and support with the tailstock centre. Turn the taper using a taper turning attachment, if available, otherwise it will be necessary to use the top slide. When it is considered that the taper being made may be close to being an adequate fit, remove from the lathe and test in the mating bore. Make adjustments to the taper setting as necessary and re-machine, continuing until a satisfactory fit results. Even when satisfactory, it will be essential to make one final skim over the taper's surface when returned to the lathe. The reason for this is that, when the part is returned to the three jaw chuck to create the parallel portions, it may not go back concentric. Now turn the $\frac{3}{4}$ in. portion at the small end of the taper and the 0.990in. portion at the large end.

It is with the 0.990in. diameter portion that concentricity is important, being the reason for making the final skim over the taper at the same visit to the chuck. The diameter is not as critical as the dimension implies, it really being only required to skim over the 1in. diameter bar so that concentricity results. Remove the tailstock and place the fixed steady in a suitable position to support the $\frac{3}{4}$ in. diameter portion. Return the tailstock centre to support the taper shank, then position and fix the arms on the steady. Now completely remove the centre and replace with a drill chuck. Drill and tap $\frac{3}{4}$ in. BSW or other thread as required, to suit the draw bar.

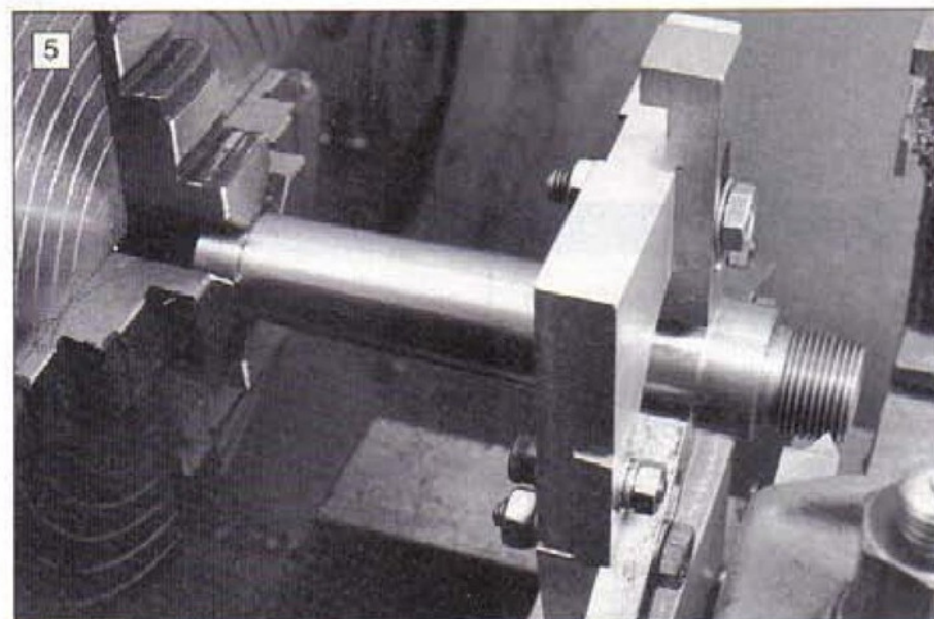
Remove the shank from the chuck and reverse, holding it on the $\frac{3}{4}$ in. portion, preferably using a four jaw chuck. The four jaw will permit adjustment to be made, so that the shank adjacent to the chuck is



2: The set up for drilling for the cutter in the small holder.



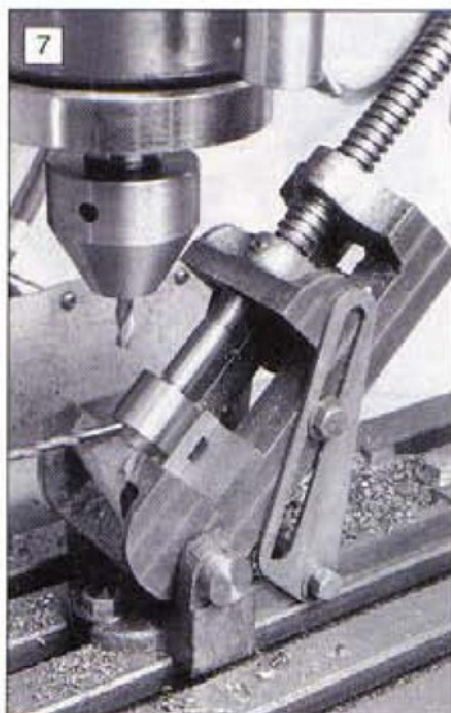
3: Preparing to make the grub screw recess. The drill is used initially to line up the holder in the vice. The drill should run parallel with the axis of the slide when viewed from above.



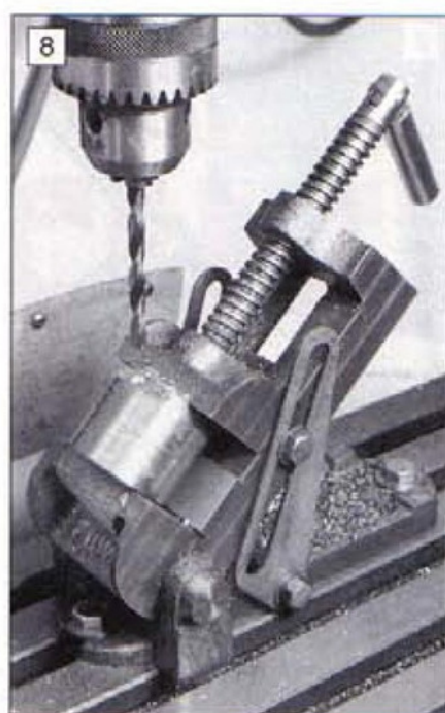
4: The two halves of the larger holder. This approach enables the shank to be used for other purposes.

5: Cutting the thread. Photograph set up after shank was completed, hence the clean machine.

6: Close-up view of the head of the larger holder, showing clearly the recesses for the grub screws.



7: Drilling the larger head for the cutter.

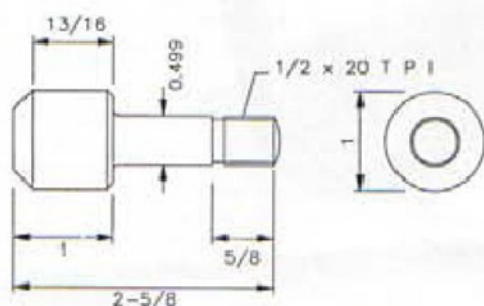


8. Making the recesses for the grub screws.

quite rightly be asking, "Why all the precautions, as being used only to support a fly cutter, concentricity is of no real importance?" This is of course true. However it is firstly a good exercise in precision turning, and secondly, if the shank does eventually find other uses, concentricity may be of important factor in these applications. Turn the end and create the 20 TPI thread, the set-up being as shown in **photo 5**.

Plenty has been written regarding screw cutting on the lathe, so I will not elaborate on the technique, other than to say that some may prefer to make the internal thread first and then to make the external thread to fit. With the shank complete, cut a length of $1\frac{1}{2}$ in. diameter by $1\frac{1}{2}$ in. long mild steel and place this in the chuck. Face end, bore and make thread as per drawing. Follow this by turning the outside diameter to $1\frac{1}{16}$ in. With the OD stepped as shown it is possible to reverse the part in the chuck and skim the remaining outside diameter, for appearance sake, without the need to exactly centralise the part using a four jaw chuck. Any error of a few thou. will not be noticeable. Face the end, set the top slide to 45deg. and make the chamfer.

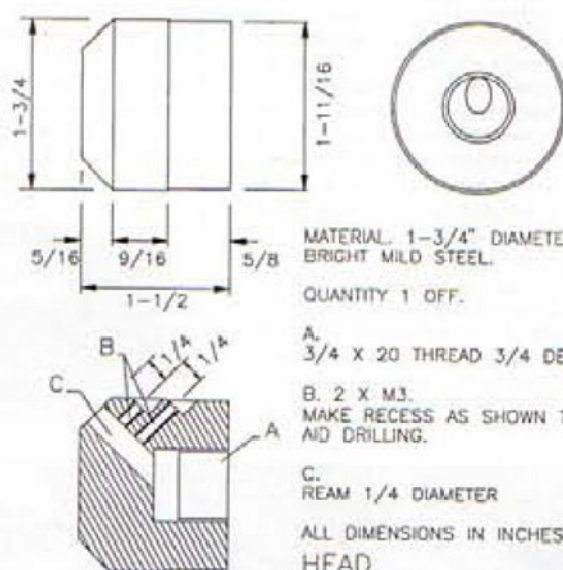
It remains now to drill for the cutter, also drill and tap for the fixing screws. Apart



MATERIAL: 1" DIAMETER BRIGHT MILD STEEL.
QUANTITY 1 OFF.
A. M3 MAKE RECESS AS SHOWN TO AID DRILLING.
B. REAM $3/16$ DIAMETER.
ALL DIMENSIONS IN INCHES.

FLY CUTTER, SMALL.

©



MATERIAL: 1-3/4" DIAMETER BRIGHT MILD STEEL.

QUANTITY 1 OFF.

A. $3/4$ X 20 THREAD $3/4$ DEEP.

B. 2 X M3. MAKE RECESS AS SHOWN TO AID DRILLING.

C. REAM $1/4$ DIAMETER

ALL DIMENSIONS IN INCHES, HEAD.

©

running true. Now support the outer end on the 0.990in. diameter with a fixed steady. This is not as easy as may at first be considered, the reason being that with the shank held only on the short $3/4$ in length, deflecting the shank at the larger end will be relatively easy, thus making setting the steady arms somewhat hit and miss. Any error, within limits, will not be that obvious, for with all three arms in contact, the shank will of course run concentric about its own axis. It will however, be being forced off the lathe spindle axis, resulting in undue strain on the chuck jaws and also to some extent, on

the lathe spindle bearings. There will be a tendency for the job to work its way out of the chuck if this condition is allowed to obtain, possibly with disastrous results to the work so far completed.

The method for minimising this situation is to slightly centre drill the end of the part when first supported. This centre mark will be concentric with the part's axis and can then be supported with the tailstock centre to finally set the steady arms. Adopting this procedure will largely eliminate any error that may have originally been present.

Having made numerous statements regarding concentricity, some readers will

from the fact that, with the larger cutter, two grub screws are provided (**photo 6**), the method of drilling etc. is much like that adopted for the smaller holder. (**photos 7 and 8**).

Cutters

Cutters can be made from broken centre drills, $3/16$ in. and $1/8$ in. diameter, or pieces of high speed tool steel. In either case a flat ground on to the shank in a suitable place for the fixing screw/screws will be a good idea to aid securing.



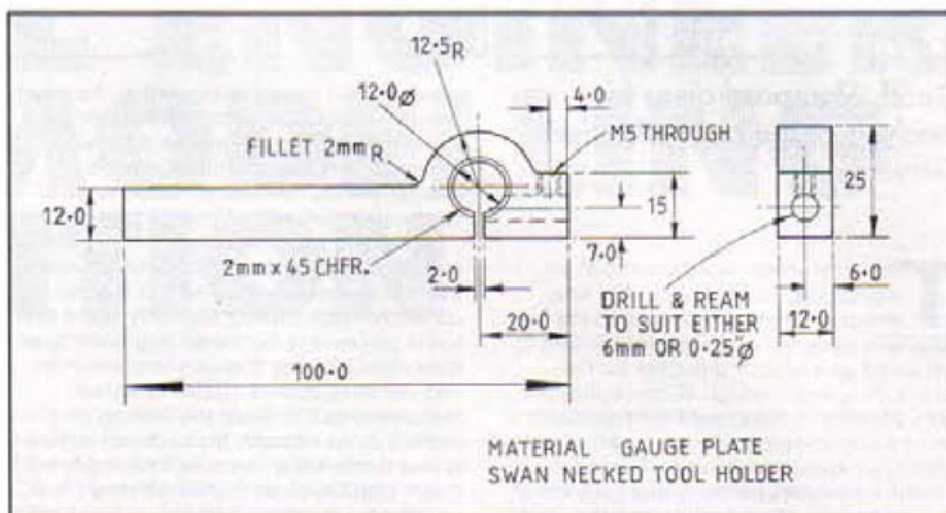
SWAN NECKED TURNING TOOL HOLDER

Do you suffer with chatter marks on items being machined on the lathe or shape. If so, then this tool holder is for YOU. If not, then it is a simple, quick to produce, item, which may still be worth an experiment. The article is provided by Dyson Watkins.

The Swan necked tool has been with the engineering fraternity for many years, but nowadays does not appear to be in general use, which I believe, to be a pity, since it can solve many a problem with poor 'finish' from 'chatter marks'. The tool holder to be described is most useful, if only for the reason that it uses for its cutting bits discarded end mills or slot drills, previously consigned to the workshop scrap bin. If you belong to the majority of machining enthusiasts who occasionally suffer from the 'chatter mark syndrome', then read on. Numerous designs have appeared over the years, many of which favoured the forged type of body with a butt welded cutting tip. When the tip finally wore out and gave up the ghost, the tool ended up in the bin! This was one of the reasons for making a tool holder, as the tips would be replaceable. The other reason being that of versatility, as the tool can be furnished with a variety of tips; suitable for turning generally as well as for screw cutting. Another point which is most useful is that since the tips are cylindrical, they can be adjusted slightly by rotating them in order to adjust clearance and rake angles.

The principle of operation of the swan necked tool is quite easy to understand if the geometry of the set-up is considered.

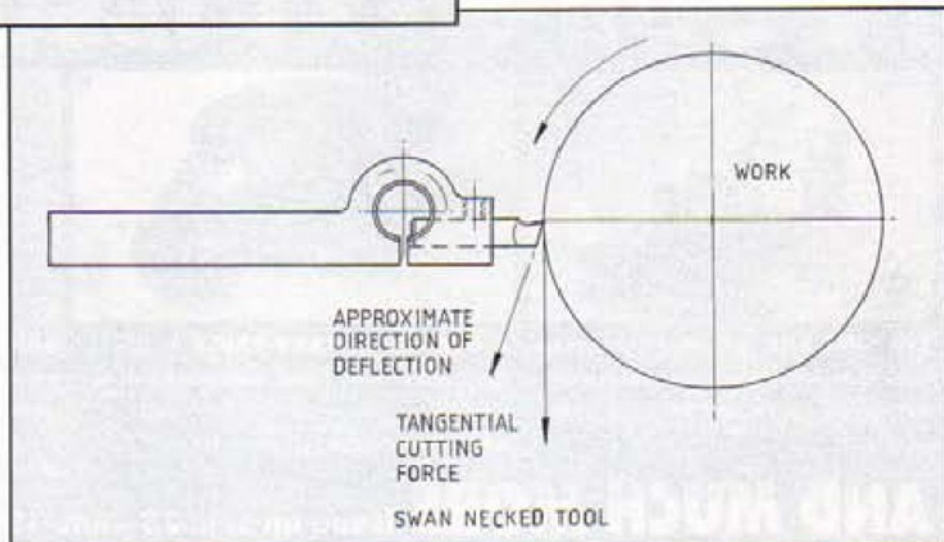
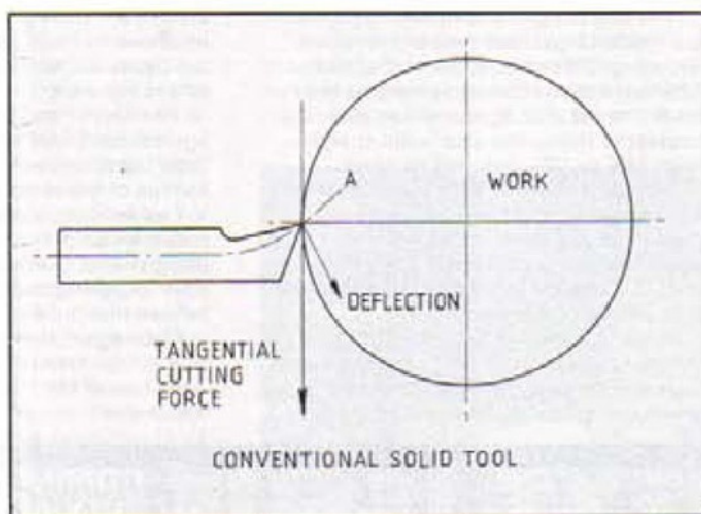
A conventional solid tool under load will deflect in such a way that the cutting tip moves further into the material being cut, even though the amount may be very small. This has the effect of suddenly increasing the tool tip load disproportionately; with the effect of removing a tiny extra deep bite out of the workpiece. This can set up vibration resulting in the all too familiar chatter pattern. The swan necked tool on the other



hand, has its centre of bending raised artificially, so that when it deflects under load, the tip tends to move away from the workpiece. This reduces the load on the tip and the vibration pattern is thus avoided.

Construction

Making the tool is straightforward, from a piece of 12mm gauge plate. Not much need be said regarding its manufacture as this is an easy little project. It is perhaps worth mentioning that the slot should be cut last of all, so that all the other machining operations can be carried out in 'solid' material. Mark out the profile of the tool on the metal, and either drill out the 12mm dia. hole on the drilling or milling machine, or clamp it on the faceplate of your lathe and machine it out. Whichever method you decide to use, it will be a little easier to carry out while the metal is relatively square and easily clamped. Chamfer the edges of the hole next. Remove the bulk of the waste from the swan neck and clean the radiused section. Next drill and ream the hole for the tool bit. Choose whichever diameter suits best according to your 'supply' of tool bits. The tool holder is also handy for use on the shaping machine, if such a machine is available.



READER SURVEY REPORT

Geoff. Sheppard gives his analysis of the recent Readers' Survey

The latest reader survey came at an opportune time for me as the new editor. It gave me a chance to see what you think of the current format and to get some idea of your thoughts for the future. By going through all the replies (all 550+ of them), it also made me feel that I was having at least some personal contact with quite few of the readers. The handwritten comments on the forms gave me a greater insight as to your likes and dislikes than any cold, statistical analysis is ever likely to do.

The general impression I get is that my predecessor, Harold Hall did a pretty successful job. To resort to the old adage, if he didn't manage to please all of the people all of the time, at least he was able to please most of the people most of the time and all of the people some of the time! I don't think you can ever do much better than that.

What do the results tell us? Well, firstly as I suspected, the age distribution of the readership is still heading upwards, with 77% now being over 50, compared with 66% at the time of the 1992 survey. More time is also being spent in the workshop, which I suspect is consistent with having more retired members in our fraternity. The age trend is worrying, not only from the point of view of the hobby, but also in respect of Engineering as a profession. We do seem to be seeing less and less young people taking an interest in things

mechanical. I am quite aware that, for most people, establishing a hobby workshop is something which can only be done when other calls on finances have begun to reduce, but we do need to devise ways of catching the interest of younger people.

What else about our readers? Still only a quarter of the readership is involved with a Model Engineering Club, which is quite consistent with the fact that only about the same percentage list model engineering as their main interest. It seems that the clubs and societies still are unable to attract those who do not count the making of models as an interest. My personal feeling is that this is a pity, because I have gained much over the years from the contact with engineers from many disciplines and from many non-engineers who were very fine craftsmen. Perhaps I have had the advantage that our local Society is one of the Model and Experimental sort, which takes an interest in anything that works (and many things that should work but don't!).

The one thing that is noticeable about our readership is that their interests are widening. Whereas, at the end of 1993, 63% listed workshop equipment as their main interest, this is now below 50%. The interest in clocks has also fallen sharply, from 34% to 12%, but with no main substitute. The list of activities is now long and varied, with vintage, classic and modern transport restoration and maintenance probably at the head. Wood related crafts are also popular and include toys and dolls houses.

What of the demands on the magazine for the future? I thank all those who made suggestions as to topics for inclusion in forthcoming issues. As you can probably

guess, these were many and varied, but I will keep all your replies on file and comb through them from time to time to try to keep in line with your preferences. If we try to keep the balance of articles related to the equipment our readers are using, then of course, lathe and drilling machine topics are top of the list. The main interest for the future, though seems to be swinging towards the milling machine, this being the most popular intended purchase, so there will be a number who wish to understand it and its operation better, and also to add accessories to extend its capabilities. New lathes, grinders and bandsaws are equally popular, but surprisingly are only just ahead of the shaper, which ties with the MIG welder.

What are your views of the current content of the magazine? As I said at the start of this report, Harold appears to have got the balance about right. For every person who says that we should have more of a particular topic, there is one who wants less. Those who complain that the articles are getting too complex are balanced by those who say that they are too basic. Some want exhibition reports, others say never!

The only strong trend that I can detect is against computer topics, but then I get a letter berating me for not publishing listings of the computer programs for the X-Y table. It does seem that interest in CAD packages is confined to those who wish to design items of equipment, often with a view to getting their work published. I believe that the debate will continue.

Once again, thanks to all those who spared the time to reply to the survey. I shall await the next one with some trepidation!



IN OUR NEXT ISSUE

COMING UP IN THE
JULY/AUGUST issue,
No. 30, will be



THE SINE BAR Bill Morris shows us how to make this accurate device for measuring angles and instructs us in its use.



A GEARED ROTARY TABLE An all-fabricated rotary table, designed around a commercially available worm and wheel is described by Mark Figs.



HAND TURNING Gordon Read initiates us into a technique which can sometimes save time and on other occasions allow us to do a job which would otherwise prove almost impossible!

AND MUCH MORE Issue on sale 23 June 1995

(Contents may be changed)

THE 64th INTERNATIONAL MODEL ENGINEER AND MODELLING EXHIBITION

An overview of the premier model engineering exhibition as seen through the eyes of the editor

The lasting impression from this year's International Model Engineer and Modelling Exhibition is that, despite the views of some of our readers, this was the year in which the computer really began to show its capabilities in our sphere of activity. On one side of the, as usual, excellent stand organised by the Society of Model and Experimental Engineers (S.M.& E.E.), their youngest member, Stephen Watkins was nonchalantly demonstrating the intricacies of computer aided manufacturing to groups of grey haired gentlemen, most of whom appeared old enough to be his grandfather. On the other side, Derek Brown was explaining, with practical examples, how computer aided design could save time and effort in the design and definition of parts for our models. The drawings for a buffer stock and head took shape before our very eyes. The founding Editor of this magazine, Stan Bray spent a long time in front of this demonstration and left declaring that it was about time that he invested in a new computer. I look forward to being able to publish some of its output! Meanwhile, on the stand of Sequoia Systems, a large computer controlled precision milling table (an industrial unit this), was switching from cutting out wooden wing ribs for model aircraft to engraving and cutting a sheet of brass into trophies for the Model Power Boat Association.

The Competition Entries - Class A5: Tools and Workshop Appliances

The catalogue listed a total of 16 entries in this competition section (one or two others were late entries) and the stand contained a most interesting selection of workmanlike products. Unfortunately the

judges decided that none of these had reached the standard required for a Gold Medal and neither was the Bowyer-Lowe Trophy awarded this year. Two Silver Medals were awarded, however, one to David Honey of Billericay for his much modified version of the Stent Tool and Cutter Grinder, while the other was won by Dr. Peter Clark of Southwold for a group of attachments for a Bofford G200 Grinder. Dr. Clark also gained a Very Highly Commended Certificate for his Wheel Measuring Equipment exhibit.

The Stent grinder, which was made from a set of unmachined castings, featured a spindle mounted on pre-loaded angular contact bearings, fully protected by

seals to prevent the ingress of grinding dust. This spindle was also modified in respect of the wheel mounting, the various wheels being fitted to tapered mandrels which are held in the spindle by a draw bar. A well fitted drawer located in the base of the unit contained these mandrels and other accessories, which also included a radius grinding attachment.

The Bofford Grinder attachments were designed to extend the scope of the machine, again basically a tool and cutter grinder, towards that of a traditional universal machine. As well as now being capable of internal and external cylindrical grinding it is now compatible with many Quorn accessories.



1: Derek Brown (centre) of the SMEE instructs Stan Bray (right) in the mysteries of computer aided design.

A Bronze Medal went to Alex Skinner of Botley for his sensitive drill head mounted on a base. An interesting feature of this was the mounting for the feed arm counterweight, which was an annulus concentric with, and sliding on the main column.

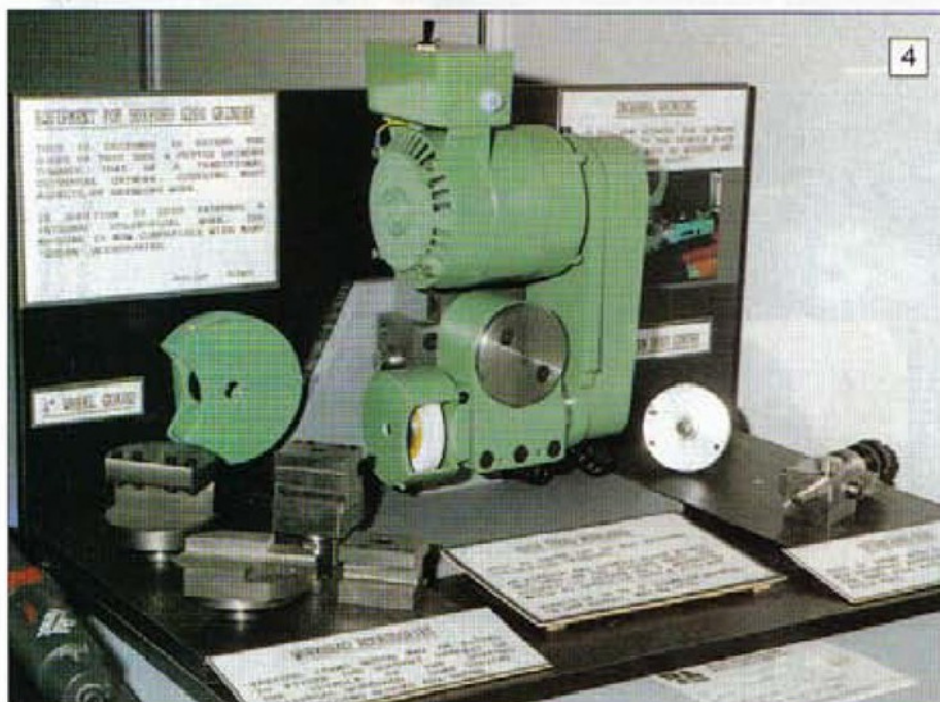
A neat all steel horizontal/vertical rotary milling table gained a Very Highly Commended for Donald Ainley of Lytham St. Annes, While Highly Commended Certificates were awarded to Peter Ellis of London for a faceplate/adjustable angle plate for a Boxford Lathe and to Tom Bartlett of Farningham, Kent for a vertical head attachment for a Senior Mill. The final award, a Commended Certificate was gained by the smallest exhibit in the class, a spot face drilling attachment made by Richard Shepherd.

Worthy of note among the entries which did not feature in the awards list was a horizontal milling adapter designed by Grahame Stothard of London, to fit on a Myford ML7, although it appeared that it would fit on any other lathe of a similar size without much need for modification. Jim Canner of Stoke Gifford, Avon showed a number of prototypes of accessories for the lathe, some of which are featured in this issue.

Taken as a whole, this section of the competition showed that good, practical tools and accessories made to designs which are capable of doing the intended job, and finished to a workmanlike standard have as much of a place in this Exhibition as the very finely detailed and highly finished scale models.



3: The accessory drawer for the Stent, showing the arbor mounted wheels and the radius grinding attachment.



4: Dr Peter Clark's equipment for the Boxford G200 grinder, which also gained a Silver Medal.



2: The modified Stent Tool and Cutter grinder by David Honey, which won a Silver Medal.

The Loan Section and Club Stands

As always, there were items of workshop equipment scattered throughout the Loan Section of the Exhibition and on the Club stands, many of these pieces having been made to designs published in this magazine or in *Model Engineer*. Some of them are, in fact, the prototypes for these designs. It is often a bit of a treasure hunt to find them, but I find that in trying to locate them and to find out more about them, I end up talking to some very interesting people and often find myself going off at a tangent to pursue some entirely different but fascinating subject! However, I did find a neat little set of bending rolls for brass angle, by Fettler and a cross-hole drilling jig, with samples of its output by Alan Bourne.

The Harrow and Wembley S.M.E. exhibit featured a dividing head and tailstock, a 6 1/2 in. rotary table and another Stent grinder, while the Ickenham and District S.M.E. stand included a small cutter grinder with a bar bed. The St Albans and District S.M.E. stand, which was judged to be the Best Engineering Club Stand included bending rolls, a sheet metal folder, a rotary milling device and a cross-drilling jig, all I believe, the work of the same person. On the Sutton M.E.S. stand was a very unusual item, namely a gear hobbing machine, basically to the Tom Jacobs design, the original of which is now in the care of the S.M.&E.E., but this one was made from the castings, which if I recall correctly, were marketed by Helix Engineering. This is the only one of this pattern I have ever seen in the finished form and I was impressed by its sturdy appearance.

The Trade Stands

Those of us who are fascinated by tools and equipment were well catered for by the trade exhibitors. It was possible to

purchase anything from the smallest of drill bits to very substantial machine tools, straight off the stands. Getting some of them home was another matter! An interesting half-hour could be spent near the main exit, especially when the Club coaches were about to leave, when many old friends could be seen staggering out under impossibly heavy loads.

With the huge range of items available it is impossible here to cover them all, so to single out particular products would not be appropriate. Some of the newer items will feature in forthcoming issues, either as product reviews or on the *Trade Counter*. What did strike me, however, was the increasingly large range of the smaller lathes now becoming available, with new arrivals from the former Eastern bloc countries featuring among them. The form in which they may be purchased and the accompanying equipment vary widely, as do the levels of finish. They all seem to have their good and less good points and the prices also vary a great deal. As always, it appears that you get what you pay for and the choice, in the end will be dictated by a balance between the capabilities required and the budget. The advantage of the Exhibition is that, whatever the piece of



5

5: The Horizontal/Vertical Rotary Milling Table by Donald Ainley, showing the many accessories. This entry was Very Highly Commended.



6

equipment under consideration, it is possible to shuttle back and forth between the various suppliers, comparing quality and prices in a way which is seldom possible even in the best of retail outlets.

Meet the Editor

An innovation this year was a stand located just inside the main entrance, where, in accordance with a rota, the editors of the various Nexus magazines involved with the Exhibition were either present on duty or on call over the p.a. system. Being very much the 'new boy' it was an ideal opportunity for me to meet some of the readers. It was especially pleasing to be able to make the acquaintance of a number of overseas subscribers, from Australia, South Africa and the United States. Quite a number of old friends from this country came along to see if it was really me in the job, and it was a pleasure to see them again. Next year, I hope it will be possible for me to meet a lot more of you.

Finally, what was for me, the outstanding feature of the Show? Easy! That incredible stand of magnificent i.e. engines. A Gold, five Silvers and three Bronze - and all from a total of nine entries. Beat that!



6: A close-up view of the Rotary Milling Table and Spherical Turning Unit.



7

7: The Horizontal Milling Attachment by Grahame Stothard

The Evolution of Drilling and Drills

In this instalment of his historical series, Don Unwin looks back at the development of what is probably for the majority of us, the first machine tool to be acquired for our workshop.

It is probable that the most common machine tool used by the amateur is the drilling machine, although in many cases it may only be a portable electric drill or even a hand drill mounted in a simple drill stand such as those in Fig. 1.

The ancestor of the drilling machine, as it was of the lathe, was the bow drill, so when you are merrily drilling a hole with your Black & Decker (or whatever) portable electric drill, spare a thought for the Egyptian carpenters or even builders of early steam engines, who had only their own muscle power on which to rely. The simple awl made of copper was known in Archaic times by the early bronze age carpenters, jewellery makers and leather workers. This was soon to be followed by the 'bow drill' (Fig. 2), and a larger version, the 'strap drill', probably used by boat builders. With this tool, the operator guided the drill and applied pressure, while two assistants, one on each end of a long strap wrapped round a bobbin on the drill body, pulled it back and forth to provide rotation. Rather labour intensive, but then labour was cheap in those days. All these used copper then bronze arrow head drills, until iron became available about 1200 BC, which was then hardened after the Chalybes discovery of a cementation process for steeling iron.

Oddly, although the strap drill and awls were known to earlier civilisations, the Egyptian representations known show only the bow drill. Hole drilling was very important to them, as all joints were pegged or fastened by thongs - no nails or screws then! Similarly, both the Greek and the Roman sources show only the bow drill, though Pliny in the 1st century AD mentions auger handles. Examples of Roman spoon bits have also been found, which probably had wooden cross-handles, to be used as augers by the wheelwright and carpenter.

Enter the hand drill

Before turning to the drilling machine itself, we will follow the development of hand drilling up to recent times. The 'pump' drill, with a flywheel of stone at first, then later of brass, is also very old and has continued in use until quite recently, employed mainly by gold and silversmiths.

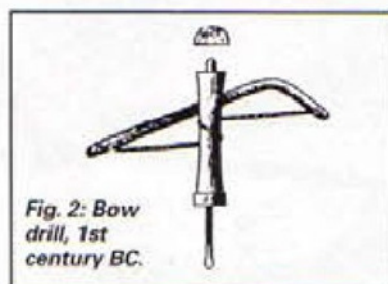
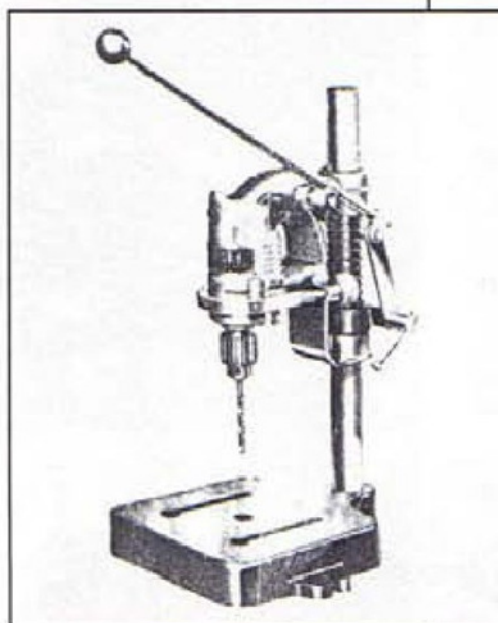


Fig. 2: Bow drill, 1st century BC.

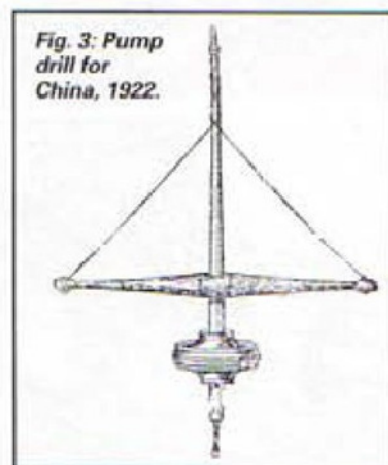


Fig. 3: Pump drill for China, 1922.

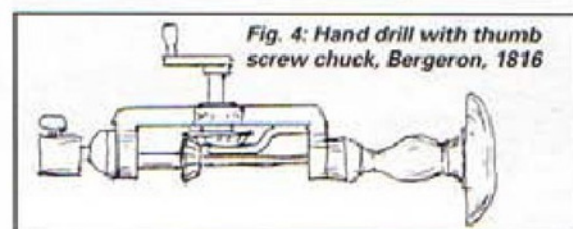


Fig. 4: Hand drill with thumb screw chuck, Bergeron, 1816

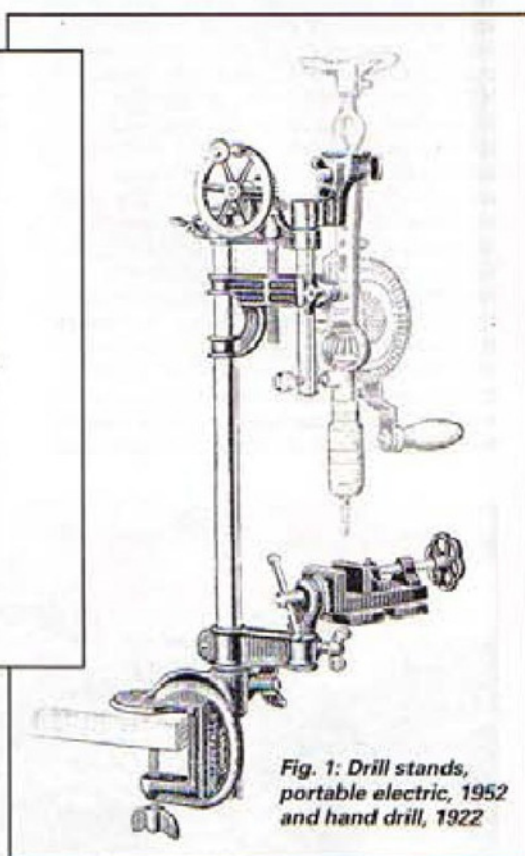


Fig. 5: Hand drill with balance bevel and 3 jaw shell chuck

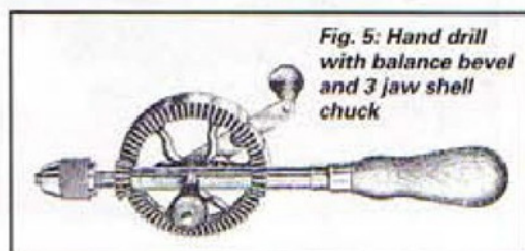


Fig. 6: Breast drill with multiple actions, 1922

Fig. 7: Ratchet brace and a universal type, 1866.

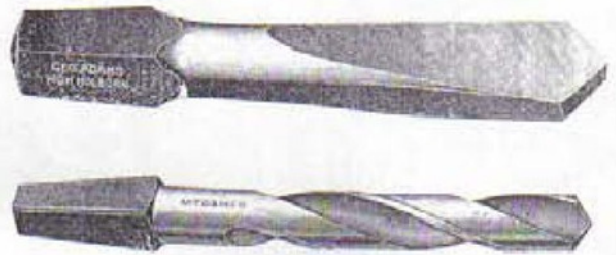


Fig. 8: Square taper shank arrow head and twist drill, 1922

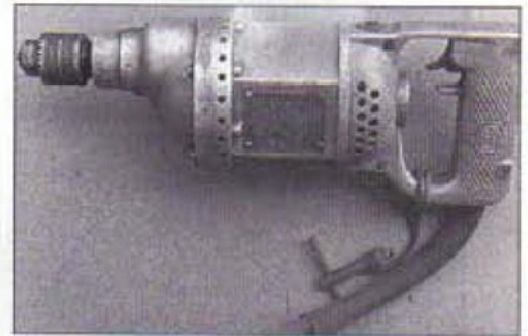
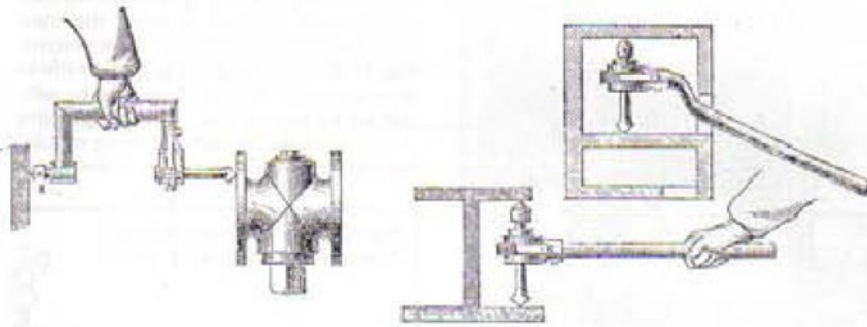


Fig. 9: Black & Decker portable electric drill, 1/4 in. capacity, c1927

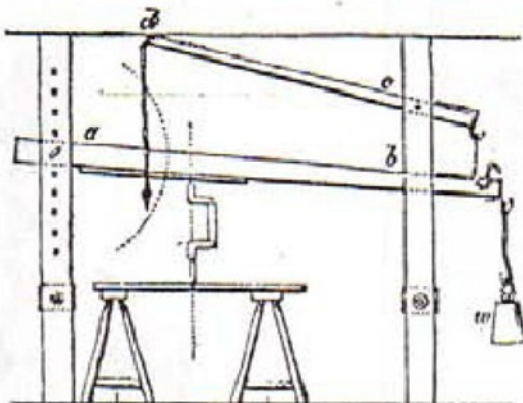


Fig. 10; 16th century weighted beam drill.

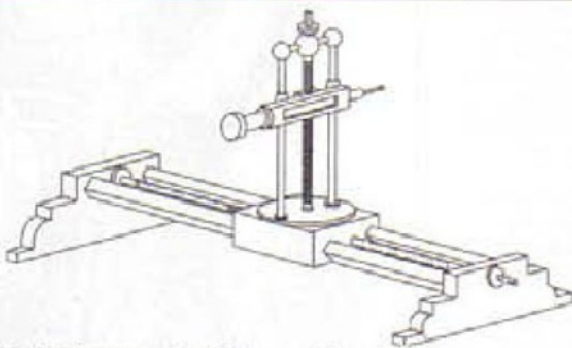


Fig. 11: Vaucanson's drilling machine, 1782.

It is listed in my old George Adam's tool catalogue of 1922 as "a drill for China" and cost 5/- (25p), (Fig. 3). In more modern times we have the 'Archimedean Drill' which was not illustrated until 1864 in Marples tool catalogue. All these drills had the disadvantage of forward and reverse

rotation, so the drill bit was usually flat 'arrow head' or 'spear pointed' and had to cut in both directions or rub on the reverse stroke, the twist drill not being invented in America until 1860. A later version of the Archimedean drill in 1892 had a ratchet and fly balls so that it continued to rotate during the return stroke of the barrel. Then about the beginning of the 20th century came the 'Yankee' reciprocating drill, a derivative of the quick acting pump action screwdriver, again with similar intermittent action.

The cranked hand-brace, the forerunner of the familiar carpenter's brace, was first described in 1420 and illustrated in 1460 by the Frenchman Tavernier d'Audenard. It was made of hardwood braced with brass, hence the name 'drill brace', until Spofford in the USA invented the iron version in 1859. Geared 'brace-drills' or 'hand-drills' were first illustrated by Bergeron in his 1816 book Manuel du

"Improved Brace Drill" with a larger gear ratio and a side handle, but still the socket and screw chuck. The final forms often had an additional idler bevel pinion to support the large bevel against the turning action and featured the shell type three jaw chuck, invented by Barber of U.S.A. in 1864 (Fig. 5). Larger ones had a breast plate and in some cases two speeds, while the ultimate had several actions such as ratchet forward, ratchet backwards, or continuous forward when the handle was reciprocated backwards and forwards, as well as two speeds (Fig. 6).

Until the invention of the electric drill in the late 19th century, probably the most used portable drilling tool for metal was the ratchet brace, illustrated by a versatile version of the 1860s in Fig. 7, with an arrow point drill as illustrated by Fig. 8, which also shows a twist drill. Both have the square tapered shank fitting into a similarly shaped socket in the end of the brace.

Electricity eases the load

The first portable electric drill, used by shipbuilders, was invented in 1887, but it was many years before they became common, being rivalled by compressed air driven tools. They were very large for their capacity - I had a 1927 Black & Decker with a 1/4 in. chuck, the body was as large as a modern 1 in. capacity drill and the chuck as large as a modern 1/2 in. When it became electrically unsafe so that I could no longer use it, I donated it to the Science Museum who wanted it as they hadn't got an example (Fig. 9).

One of the first really small portable industrial electric drills of 1/4 in. capacity was probably that made by Desoutter in the 1930s, whose principal products were pneumatic powered portable tools. Soon after the end of World War 2, Wolf made a

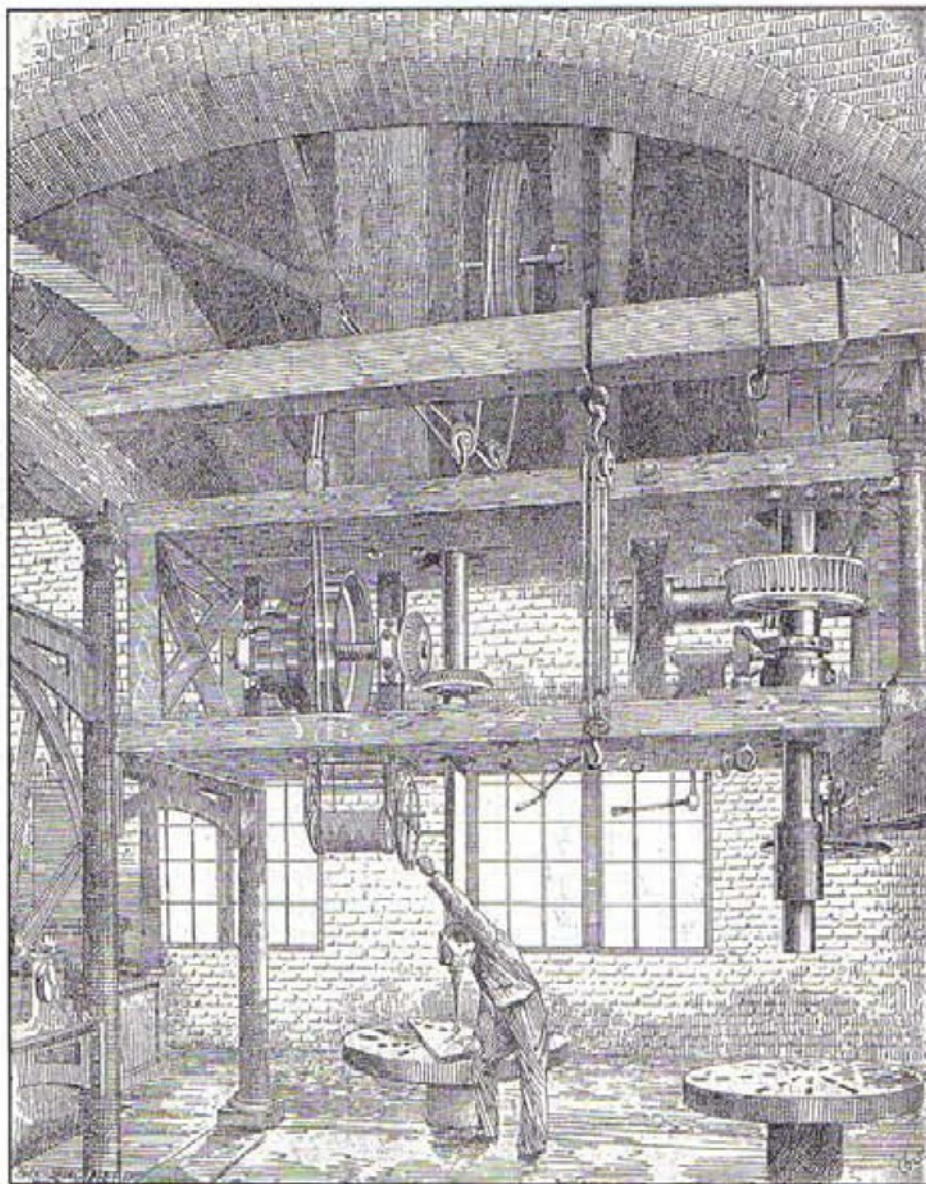


Fig. 12: Soho Foundry drilling machine, c1800? *Engineer*, 1895

small electric drill for the growing DIY market with an unorthodox $\frac{1}{4}$ in. capacity chuck. These were very prone to armature burn-outs. Bridges, Stanley, Black and Decker and others soon entered the field. Now we have true portability, with cordless rechargeable battery driven drills, a large step from the Stone Age bow drill!

Back now to the 18th century. While clock and instrument makers used the bow and pump drills for making their small holes from early times, and the blacksmith produced his holes by punching or forging the iron when hot, we have no knowledge of how larger holes in metal were produced before the middle of the 18th century. Possibly the weighted beam drill used by blacksmiths and wheelwrights up until the 19th century (Fig. 10) was used. There are no illustrations of drilling machines before 1750 and very few surviving examples until those from the early 19th century. One early surviving machine is that made by the French engineer Jacques de Vaucanson in 1782 (Fig. 11), probably for some special purpose. His machines were in advance of their time, with prismatic guides for the carriage about $1\frac{1}{2}$ in. square, placed at 45 degrees to the vertical. Another of his innovations was the oldest known rotary formed milling cutter.

The larger machines

Two drilling machines were listed in the Soho Foundry plant list of 1801, both upright, one large and one small. When *The Engineer* visited the Foundry in 1895, they illustrated one of these machines, which at that time was reported to be over 100 years old, so is probably the large one referred to in the plant list (on the left in Fig. 12). As it is built into the structure of the building, it was certainly very early, as this practice had fallen out of fashion by 1820, although it must have been modified at some time as it was listed as being single speed.

The upsurge of the steam engine at the end of the 18th century encouraged the development of machine tools, including the drilling machine that soon appeared in various forms. We have an illustration c1840 of a power driven pillar drilling machine in the works of Robert Napier in Glasgow (Fig. 13), and about the same time, James Nasmyth had introduced his 'portable' hand drill in his works (Fig. 14). Earlier, in 1827, when he was still working for Maudslay on the model steam engine, he devised the contra-wound spring flexible shaft to drive a drilling spindle to drill holes in difficult places on the model. He never patented it and many years later

had his teeth drilled by a dentist using the 'newly invented' flexible shaft dentist's drill!

Joseph Whitworth entered the fray in 1847, with a pillar drilling machine with counter balanced spindle, a rack and hand wheel feed instead of the more normal screw feed, and a three step cone pulley drive with back gear, similar to that used on lathes. The table knee could be adjusted up and down the column guide-ways by a rack and pinion and the circular table was rotatable (Fig. 15). Soon after, in 1850, he introduced a similar machine with x and y screw driven traverses in the square table. By 1860 machines had appeared where the flat table knee guide-ways were replaced by a circular column, whereby the knee could be swung sideways. That shown in Fig. 16 is a typical example. Note the back gear and the small cone pulleys by which self acting power feed could be obtained.

Meanwhile, the radial drilling machine had appeared, in which the drilling spindle

Fig. 13: Pillar drilling machine, Robert Napier's Works, 1840



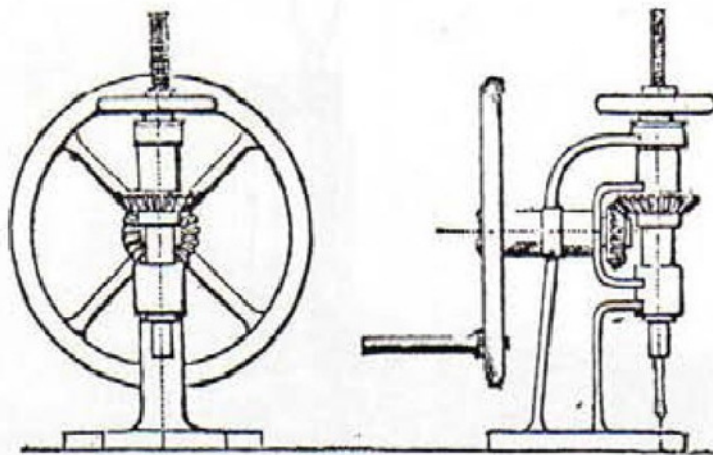


Fig. 14: James Nasmyth's 'portable' drilling machine, c1842

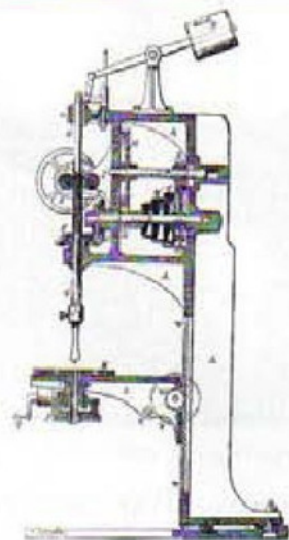


Fig. 15: Joseph Whitworth's pillar drilling machine, 1847

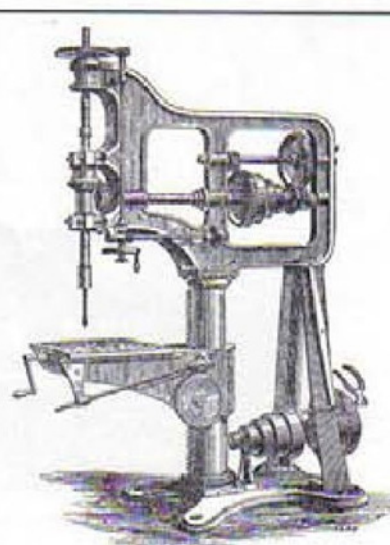
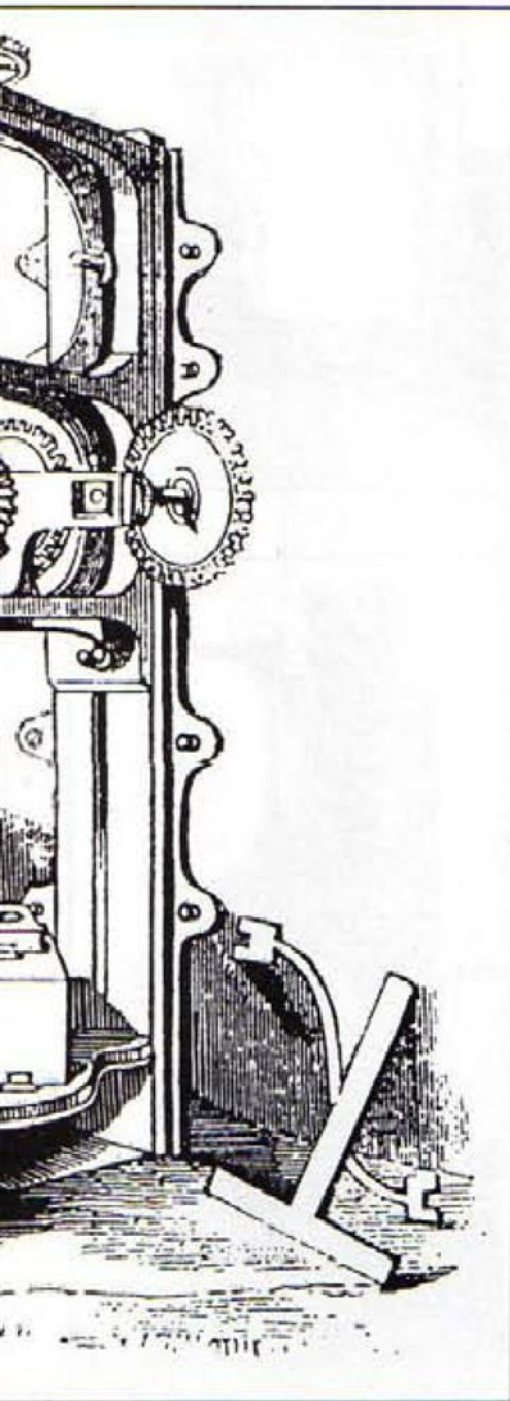


Fig. 16: Pillar drill with circular column, 1866

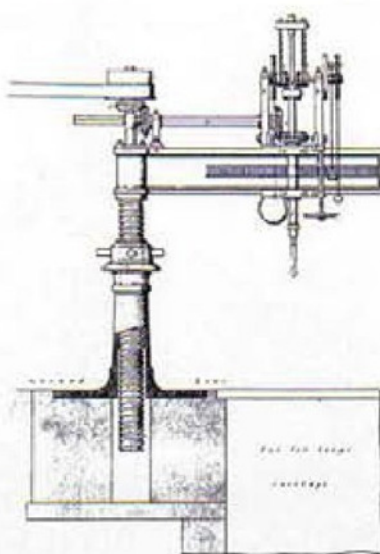


Fig. 17: Benjamin Hick's radial drilling machine, 1838. *Practical Essays on Millwork*, Buchanan, 1841

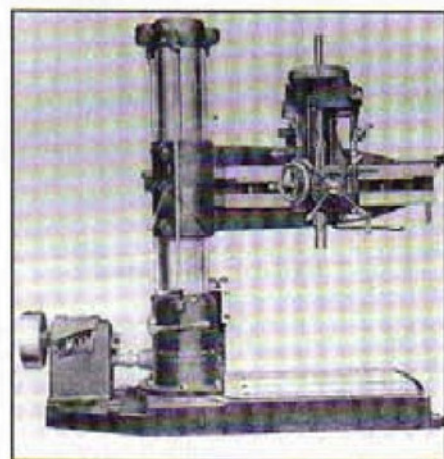


Fig. 18: Belt driven radial drill c1915

horizontal beam fixed to a vertical column. Benjamin Hicks & Son are claimed to have introduced this idea that is particularly useful for heavy components which need not be moved to position the drill. On the Hicks machine, to vary the height of the horizontal beam, the column was threaded and adjusted vertically by a large nut (Fig. 17), but this arrangement soon fell out of favour, to be replaced by a fixed circular vertical column with the beam sliding up and down as in the more modern machine shown in Fig. 18. The single pulley belt drive and gear box to give speed changes is interesting. Other types of radial drilling machines were developed for special purposes, for example the girder drill (Fig. 19) and the portable(!) 'universal' radial drill (Fig. 20). Derived from the radial drill, with the drilling head adjustable along a massive beam, was the machine for drilling boiler barrels (Fig. 21). The horizontal drilling machine, in which the spindle was mounted horizontally for drilling the ends of long work is shown in Fig. 22. To go back to c1840, four radial drilling machines designed by Harper were installed at the Soho Foundry and built into the building structure (Fig. 23). The illustration shows one of a pair on either side of a gateway and railway track,



Fig. 19: Radial girder drill, c1930

whereby work could be drilled without removing it from the wagon!

Multiple spindle machines

In 1848 Richard Roberts made a machine for drilling large numbers of holes in clock plates using a template and in 1860 James Cochran made a multiple spindle machine for drilling eighty 1 in. diameter rivet holes in bridge girders. To obtain the large force necessary, he used Bramah's hydraulic ram. In the same year, Andrew Shanks made a multiple spindle machine in which the spindles were driven by a crank plate. Speed was limited by the inertia of the heavy crank plate and the centres of the holes were not adjustable. Soon after, machines were made with the adjustable centre spindles driven by a belt looped round them, but these sometimes needed right and left hand sharpened drills. In America, the multiple spindle machine soon appeared for use in the small arms industry, and in 1859 the Lincoln Company were making a 4 spindle machine, in which the feed was applied by raising the work table by means of a foot treadle, thus leaving the operator's hands free. Later

Fig. 21: Boiler barrel drilling machine, c1930

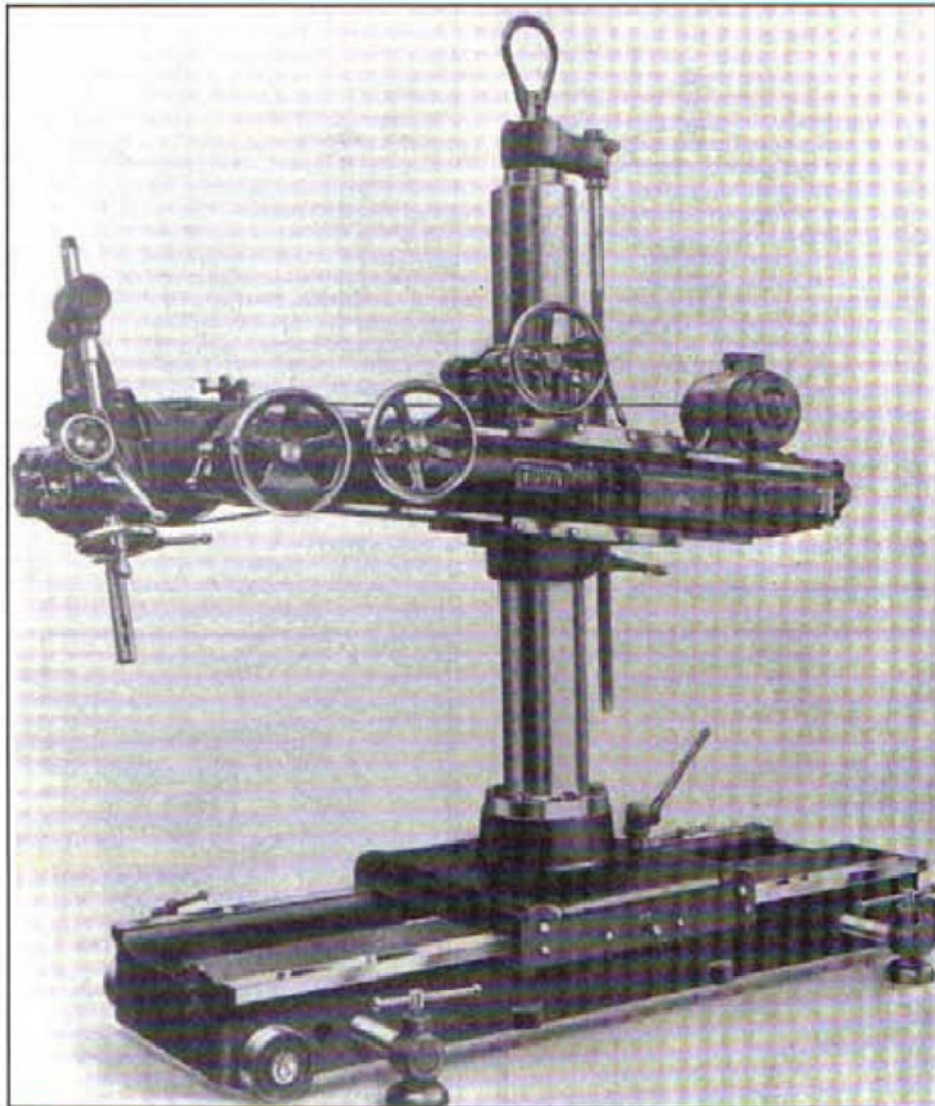
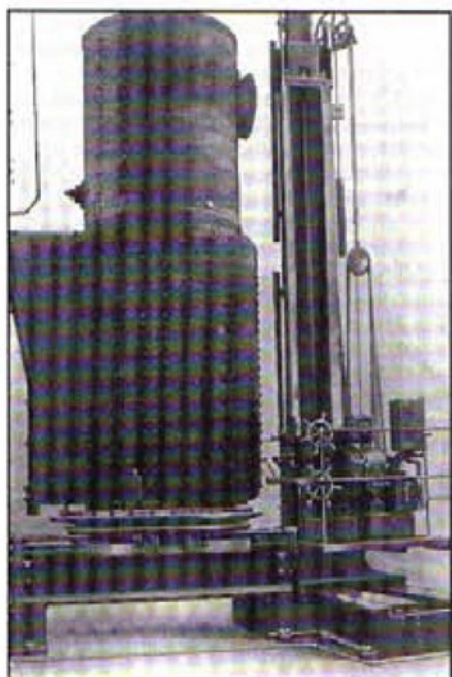


Fig. 20: Portable 'Universal' radial drill, c1930

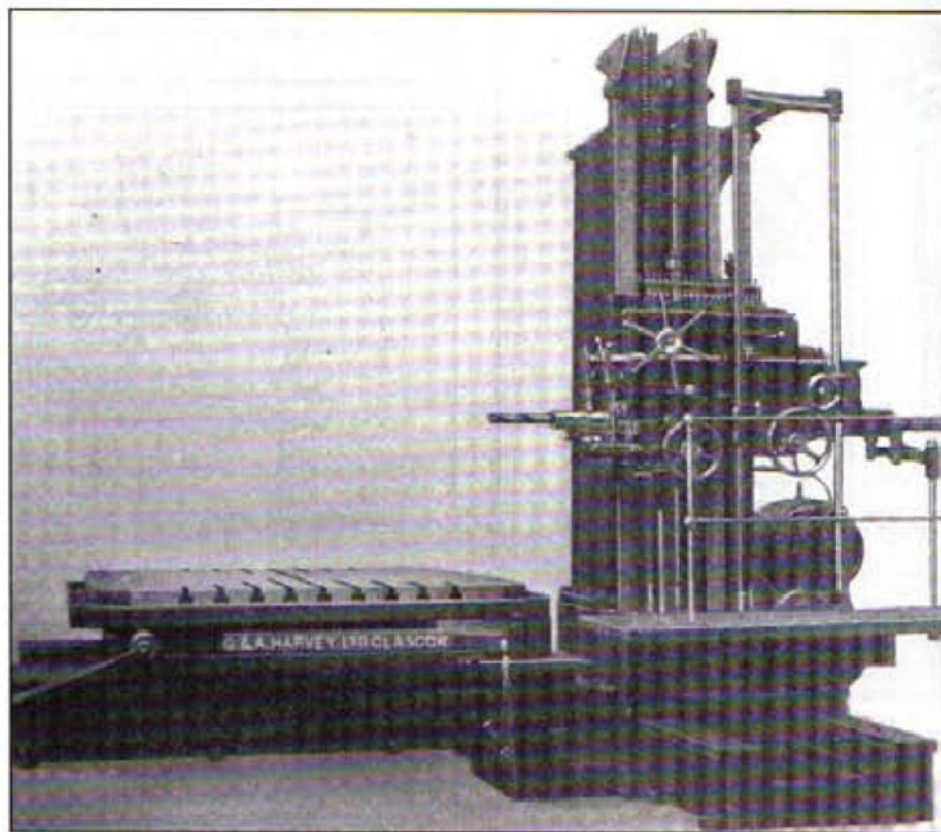


Fig. 22: Horizontal drilling machine, c1930

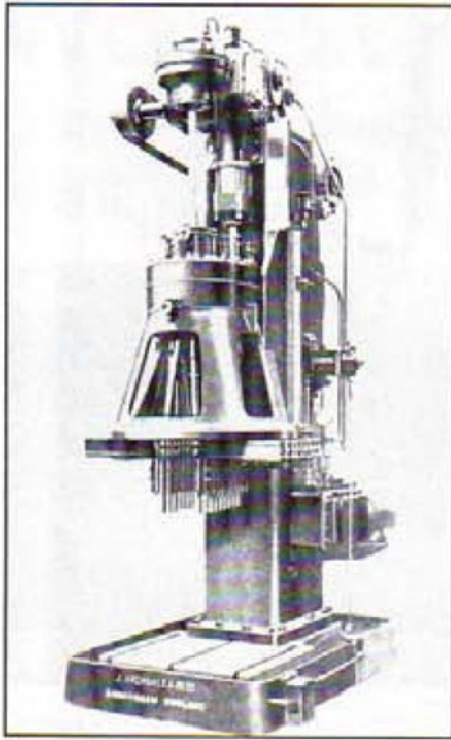


Fig. 24: Archdale 36 spindle multiple drilling machine, c 1930

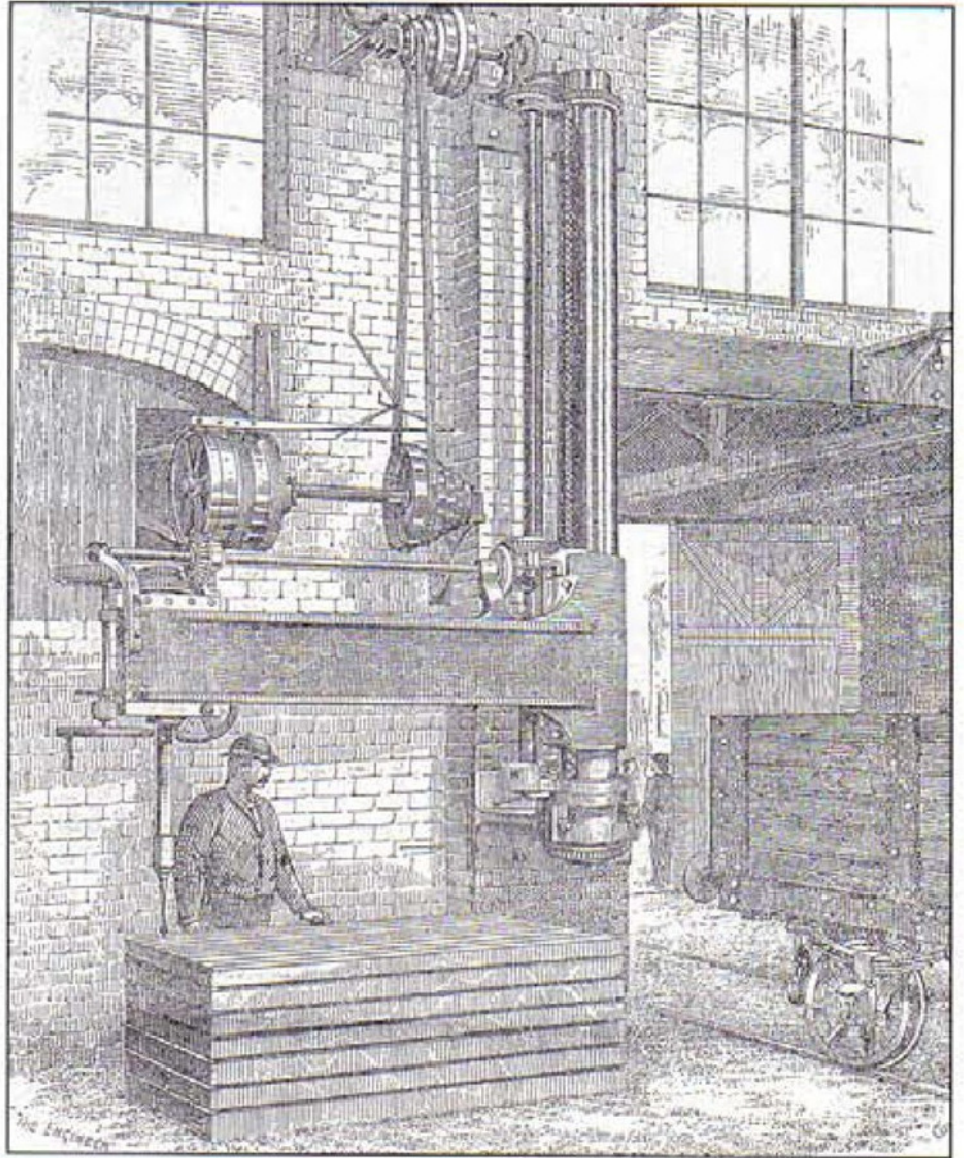


Fig. 23: Radial drilling machine, Soho foundry, c1810? *Engineer*, 1895

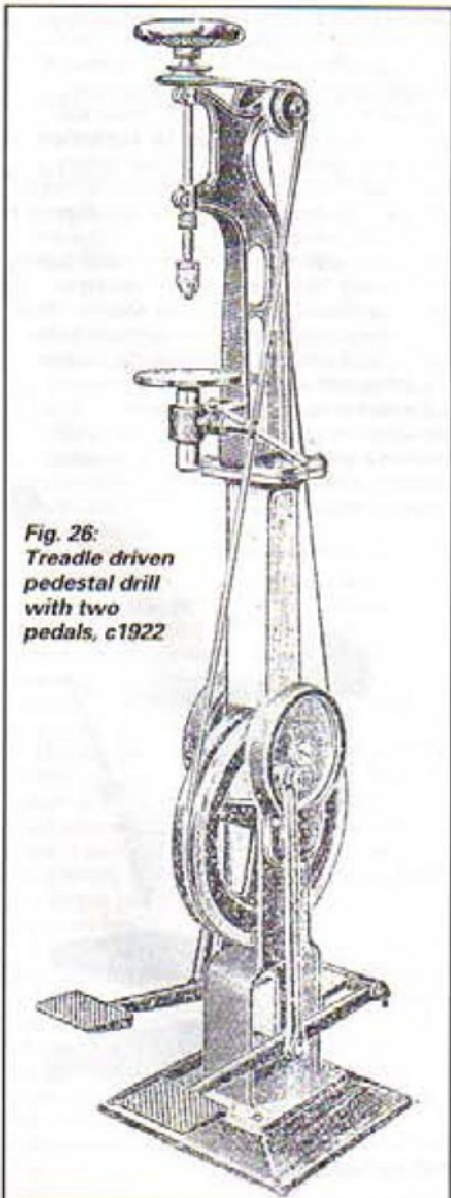


Fig. 26: Treadle driven pedestal drill with two pedals, c1922

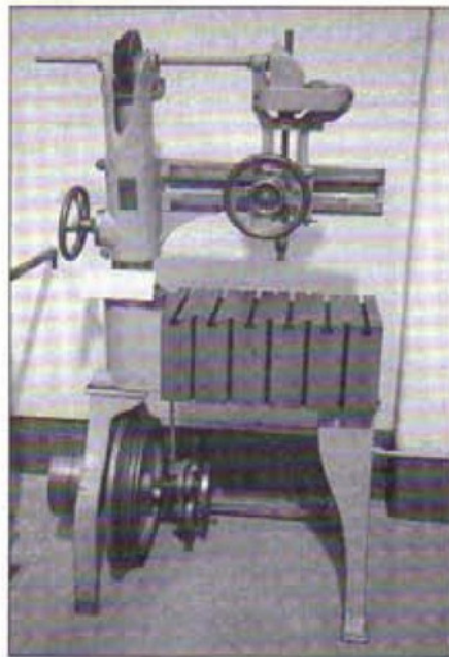


Fig. 25: Archdale treadle radial drill, 1906. Birmingham Museum of Industry.



Fig. 27: Precision bench drill, c1910



Fig. 28: Weighted beam drill, 19th century. Stockwood Craft Museum, Luton.

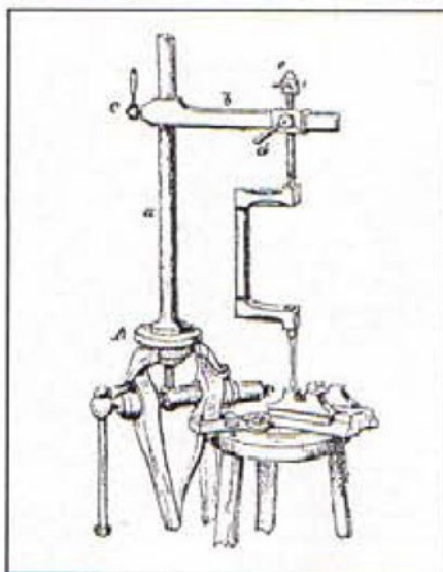


Fig. 29: Screw fed blacksmith's drill, mid 19th century

developments included spindle drives by universally jointed shafts that allowed adjustment of the centres as shown in Fig. 24.

By 1860 the basic design of the drilling machine had become fixed and subsequent improvements were in strength, drives and the grouping of controls to more convenient positions. One innovation in 1885 however was by the Square Hole Drilling Machine Company of London. Their machine used a triangular drill driven by a universally jointed shaft and guided by a template. In fact, an 'x' sided drill would produce an 'x+1' sided hole - see MEW Dec. 1992/Jan. 1993 page 14.

The twist drill

Probably the most important development was, however, the invention of the twist drill. Introduced in America in 1860, but not available in the UK until about 1880, they were first used by the Providence Tool Company on small arms production, the flutes being laboriously filed! It was the invention by Joseph Brown in 1862 of the 'universal' milling machine, with the adjustable table and dividing head geared to the traverse screw specifically for

milling the flutes, that enabled them to become generally available. The Morse Twist Drill Company pioneered their production in quantity, and also introduced the Morse taper shank, with a driving tang to fit in a matching socket in the drilling machine. Drills were held in the machines in various ways. Some had square taper sockets, the same as the ratchet brace, so could use the same drills. Others had a parallel socket with set screw, while some used a crude form of two jaw chuck. A.I. Jacobs of the Jacobs Manufacturing Company, USA invented the key chuck that carries his name in 1903, by which time there many types of two jaw chuck, plus Barber's shell chuck of 1864 for smaller drills.

Although the larger machines were belt driven from a power source, many smaller machines were treadle driven, for example, the little Archdale radial of 1906 now in the Birmingham Museum of Industry (Fig. 25). It was still being advertised by George Adams in 1922, together with other treadle pillar drills (Fig. 26). Note the two pedals which allow both feet to be used. My father's drilling machine c1910 (Fig. 27), upon which I 'cut my teeth' was rigged up by him to be treadle driven, like his Relmac lathe, until we motorised them about 1936.

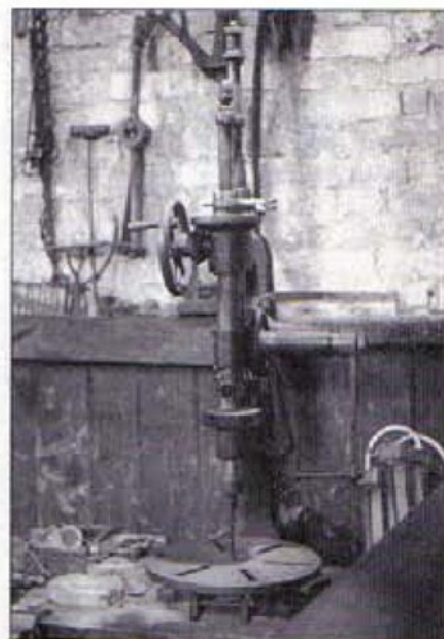


Fig. 30: Blacksmith's hand drill, 19th century. Stockwood Craft Museum, Luton.

We know that the machine can't be earlier than about 1903 when the Jacobs chuck, with which it is fitted, was invented.

Hand powered machines were also used. The blacksmith had the weighted beam brace drill (Fig. 28), and in the mid 19th century a development of it, the simple hand brace, with the pressure applied by a screw (Fig. 29). Later wall drills as illustrated by Fig. 30 were used until very recent times. The availability of the small fractional HP electric motor and the vee belt drive allowed the development of the self contained drill press in the late 30s, often with 5 speeds, (some with back gear giving 10 speeds) and in bench or floor standing forms. Fig. 31 My experience with those first to arrive from U.S.A. in about 1940 was that they were not all as stiff as they should be and deflected under drilling pressure.

However, many good makes are now available and they have rightly become popular with industry and the amateur alike.



Fig. 31: Self contained drill presses, US made c1940, UK made c1955.

We Visit CHESTER U.K. LTD.



1 & 2: Views of the main showroom at Chester U.K.

The Editor was heading South from Chester and took time out to visit one of our advertisers, a Company which markets machine tools and equipment of interest to anyone establishing or expanding a home workshop.

Chester Machines first came to our attention late in 1992 with an advertisement for an all purpose machine for the model engineer, being marketed from an address in North Wales. The machine was seen at a subsequent Model Engineer Exhibition and proved to be rather intriguing as it consisted of a centre lathe of greater centre height than the conventional model engineer's unit, mated with a mill/drill head mounted atop the headstock.

The Company has now evolved into Chester U.K. Ltd., having greatly expanded its range of machine tools and equipment, and has relocated to the Waverton Business Park, Waverton near Chester. A recent visit to the area gave the opportunity to drop in and take a closer look at their wares.

The Business Park is clearly signposted off the A41 south of Chester, just a few hundred yards to the west of the main road. Ample parking is available, a vital point if contemplating collecting heavy equipment. I was greeted by Chris O'Hare, one of the two brothers who run the organisation.

His brother, Michael was at that time actually in mainland China, a country with which the family has had connections for some years. Indeed, Michael's wife Mimi, who is also a mainstay of the business, hails from those parts and Michael is proficient in Mandarin. After representing a Taiwanese manufacturer in China, he established a business relationship with a Chinese company, which led to Chester Lathes.

The main part of the showroom is simply laid out with examples of all the principal items in the catalogue, and has ample room for any prospective purchaser to carry out a thorough examination of any of the machines which takes his interest, and also to compare the Company's products, one with another.

Conventional centre lathes cover the spectrum from the little Companion II, with a centre height of 65mm and 300mm between centres, up to the mighty geared head Craftsman, which can swing a 305mm. diameter job and boasts no less than 18 speeds and 910mm between centres. The Multi-Purpose Machine now comes in two versions, both able to swing 420mm over the bed. The more popular version (Model B) has the advantage over the Model A that the milling head can be raised or lowered, obviously adding to its versatility.

Apart from a milling attachment for the 110mm centre height Champion lathe, two of the familiar mill/drills are produced, the Champion and the more substantial Eagle. The former, which replaces the earlier BM25 is, in effect, the milling head from the Champion lathe combined with a free standing milling table, thus making a compact turret mill. Two 16mm capacity drill presses are available, one being an industrial unit with a threaded column, but for those really wishing to drill big holes in large objects, the RDM25 radial arm drill will take some beating! This unit, I am told has found favour with a local stonemason, who is able to manoeuvre large chunks of marble and granite on to its table with the drilling head swung out of the way.

The many other, smaller items which make up the Chester U.K. range are also on display, a number of them in the newer front section of the showroom, where additionally quite a number of the high quality small tools from the C.K. catalogue may be purchased.

Although time did not allow a detailed examination of all that was on show, a general impression was gained of products which are substantial and workmanlike. Chester U.K. compile the specification of



3: The range of small tools and equipment on display in the new front showroom.

the units which carry their name, defining the sources of such components as electric motors and control gear, as well as requiring modifications to the basic units if they feel that these will enhance performance. One example of this was a change to one of the lathes, which originally featured the familiar graceful curve in the underside of the bed, between the mounting feet. This has been replaced with a rather uncompromising looking box section, which must have done wonders for the stiffness of the unit. A very full range of accessories and attachments is listed, which should make these products as versatile as any on the market.

In addition to the machine tools and equipment from China, there are some locally made products, as all the sheet metal machine bases are made on site. If space constraints demand a specially shaped cabinet stand for your choice of machine, then it is worth producing a sketch, because I am sure that the team at Waverton will do their best to accommodate your requirements.

Address

Full details of all the Chester products are available from Chester U.K. Ltd., Waverton Business Park, Waverton, Chester CH3 7PD. Tel. 01 244 336100 Fax. 01 244 336036



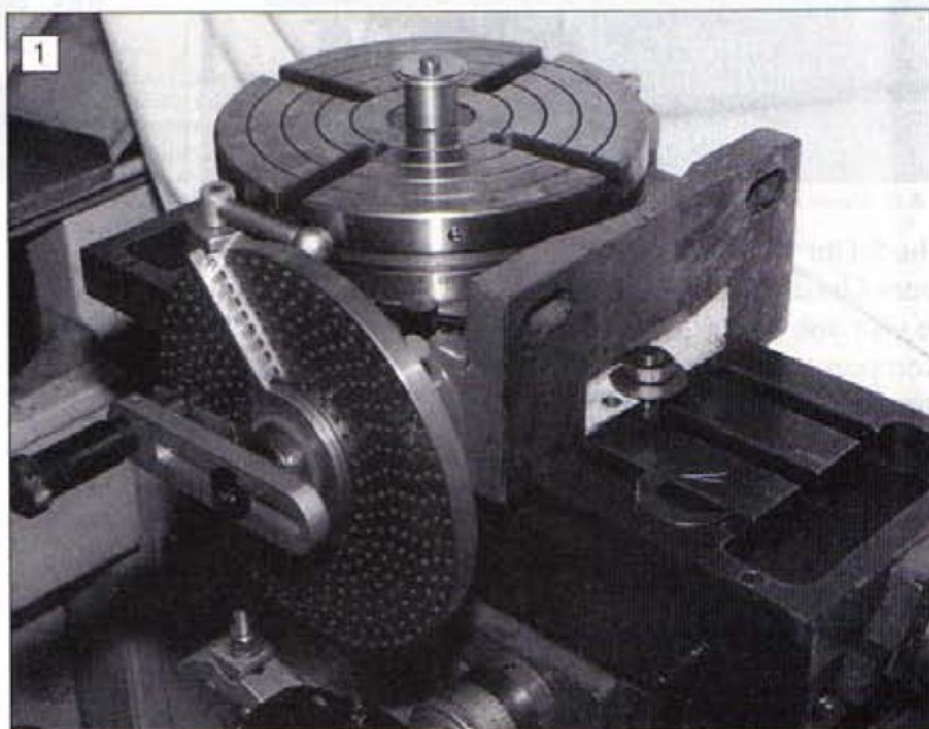
GETTING MORE OUT OF YOUR ROTARY TABLE.

One of our contributors resident in Australia, Philip Amos, describes how he has extended the versatility of his Taiwanese manufactured rotary table. Although the detailed dimensions may need to be changed, the same principles can be applied to many combinations of table, drill/mill and lathe.

Note: It is probably evident from the drawings that I prefer to work in metric units except for fixed tooling such as screwing tackle & reamers. Dimensions given on the drawings show metric replacements for the BSW threaded items, which in some places are becoming very difficult to obtain. (Threads used in the prototype are shown in the materials lists). These will need to be modified to suit reader's own particular machines, should anyone wish to make similar arrangements.

1. Introduction

After acquiring a Taiwanese drill/mill in 1984, it seemed that it would be useful to have some form of indexing equipment to allow more varied milling activity to be undertaken. There were available Taiwanese dividing heads and also rotary tables. The latter appeared to be more robust so one of these was purchased (**Photo 1**). It has an 8in. diameter table - a bit on the big side for the drill/mill (model RF-15 the smallest of the three sizes available), but the 6in. diameter rotary table could not be obtained with a companion tailstock. The table came complete with a set of division plates allowing dividing for all integers from 2 to 100. These plates are 11.7 mm thick, double sided with blind holes. Additional plates can readily be made to match, 6 mm thick with through holes. I have made one such with 25 holes for a job I no longer recall. One deficiency with the dividing equipment as supplied is the arrangement for holding the sector arms in place. This



Rotary table on drill/mill table, with dividing plate mounted. Also showing centring plug and defective sector arm spring.



Table and tailstock on sub-base, set up for between centres work.

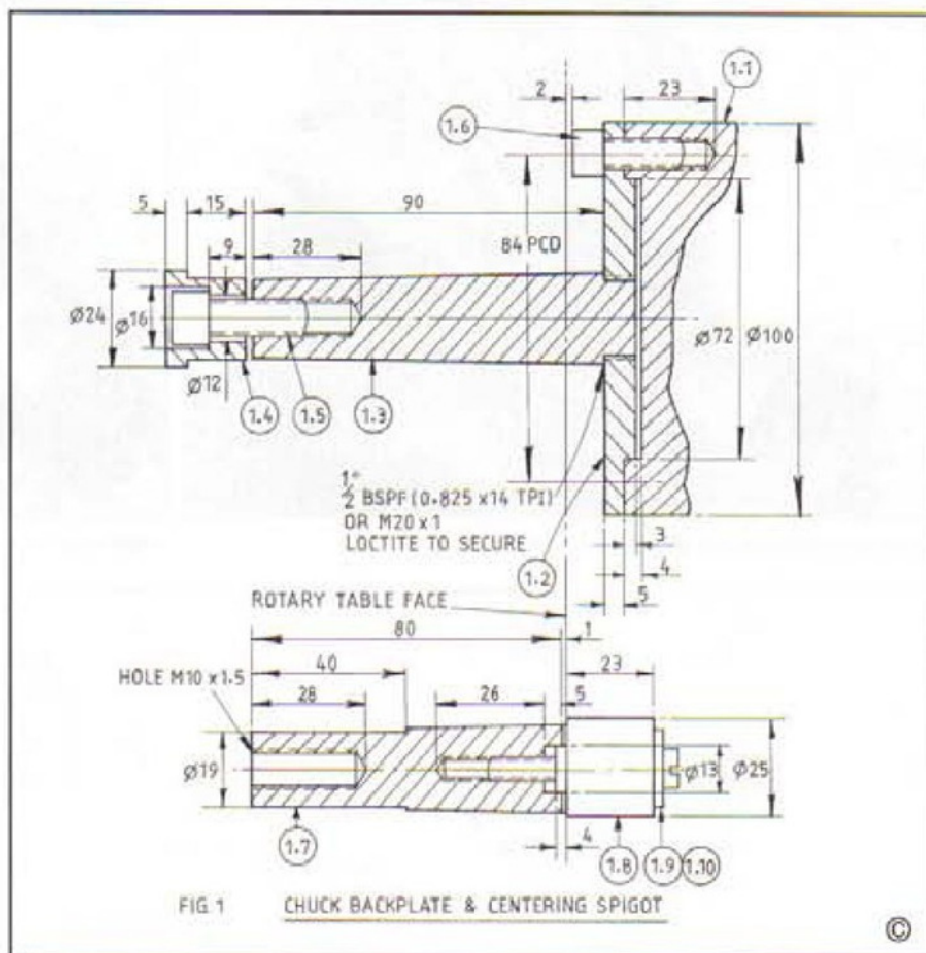
comprises a C shaped brass flat spring seen resting on the table in **Photo 1**. This works out of its groove on the shaft as soon as the sector arms are moved - it is a useless design. As a substitute arrangement, a red fibre washer is held against the sector arms by a bush close fitting on the shaft and secured with 2 setscrews. This works well. The rotary table is designed so that it can be laid flat on its back on the machine table, or else stood on one end so that its rotating axis is horizontal. Dividing heads have the advantage of being able to operate at any angle between horizontal and vertical, and for some years this was not seen as disadvantageous to the rotary table, until some jobs turned up that needed just this facility. A solution to this problem is described below.

2. Attachment to Drill/Mill

To use the rotary table at all required means to attach it to the drill/mill table. When laid on its back, two T bolts with nuts and washers covered this, but when standing vertically on end, the positions of the slots in the rotary table and the drill/mill table do not match. Furthermore, the length of the slots in the drill/mill table allow little room to mount the tailstock and hence only a limited length is available for the workpiece. To address this, a piece of steel plate 21 x 8 x 1/2 in. was surface ground on both faces and drilled with a pattern of holes to allow its attachment to the drill/mill table. It was also drilled and tapped with another pattern of holes to allow the rotary table and tailstock to be attached to it in appropriate places. (**Photo 2**). The attachment holes allow the mounting screws to be positioned so as to avoid the tailstock footprint, and also allow some flexibility in the lengthways positioning of the sub base on the drill/mill table. Perhaps only 4 countersunk holes could be used with socket countersunk screws, but at the time of construction there was no suitable countersink cutter available.

3. Holding Work

The rotary table has 4 radial T slots suitable for 3/8 in. studs and T nuts, and a central 3MT hole. Thus work can be mounted between a 3MT centre and the tailstock centre, or can be bolted down in the normal faceplate fashion to the rotary table surface (**Photo 2**). In the latter case, to facilitate centring, a 3MT plug has been



CHUCK BACKPLATE AND CENTERING SPIGOT - Materials List

Item	Description	Material	Qty
1.1	Chuck 3 Jaw 100mm		1
1.2	Backplate	Black Mild Steel 100 dia. x 8	1
1.3	Shank 3 Morse Taper	Black Mild Steel 125 dia. x 98	1
1.4	Bush	Black Mild Steel 25 dia. x 20	1
1.5	Screw Cap Head Socket	Steel M10 x 1.5, 25 long	1
1.6	Screw Cap Head Socket	Steel To suit Chuck	3
1.7	Plug 3 Morse Taper	Black Mild Steel 25 dia x 80	1
1.8	Bush O/D as required	Black Mild Steel	1
1.9	Screw Cheese Head	Brass 1/4 BSW (or M6) x 45 long	1
1.10	Washer	Steel, Zinc plated. 20 x 7 x 2 thick.	1

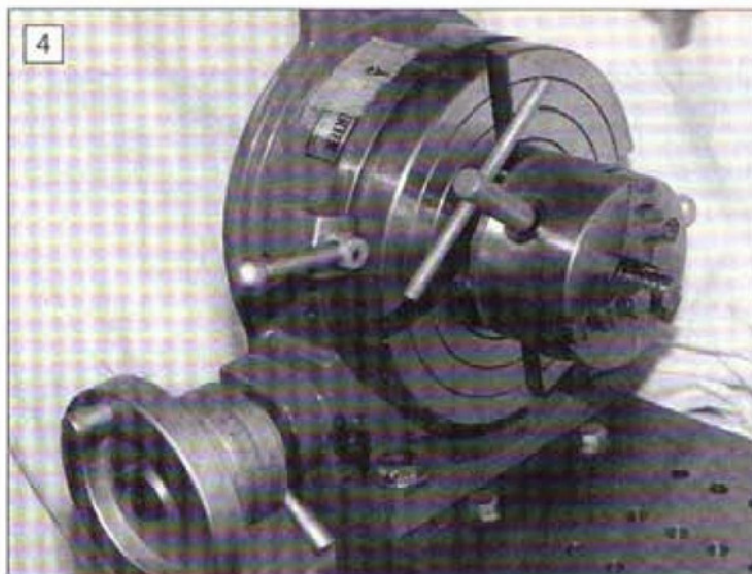


3
Chuck, backplate and 3MT spigot, with retaining bush and screw (above). Centring spigot below.

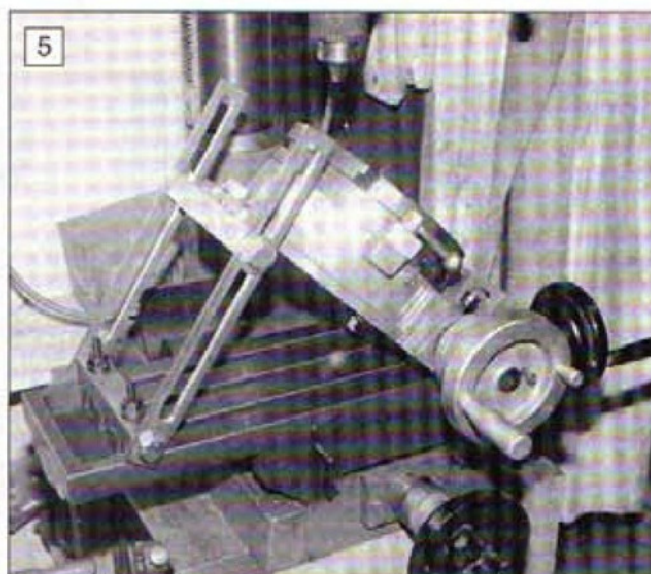
made having a 13 mm diameter recess 5 mm deep at the top, with a 1/4 in. BSW hole tapped 31 mm into it. A series of shouldered bushes was made as required, each fitting into the recess and having an outside diameter to suit whatever hole in the work is to be centred on the rotary table. The bush is held in place against the table face (or the plug face for small ones) with a washer and cheesehead screw. (**Photos 1 & 3 and Fig.1**).

My lathe is of Taiwanese manufacture, 6in. centre height,

36in between centres. Its mandrel is bored 4 1/2 MT - not a book standard, but it is intermediate between 4 and 5MT and has a similar taper. A bush was supplied for a 2MT live centre, but as the quill of the drill/mill is 3MT, another bush has been made 4 1/2 to 3MT, to allow use of accessories on both machines. In this case the plug was turned to 3MT and by trial in the rotary table the required length was established to get its upper face just below the surface of the rotary table. The plug is held in place with a M10 socket head screw in a recessed and stepped bush, which acts as a drawbar and does not project from the rear of the rotary table. For cylindrical or



Chuck with original key (Fouls table face)



Angle supports and attachments.

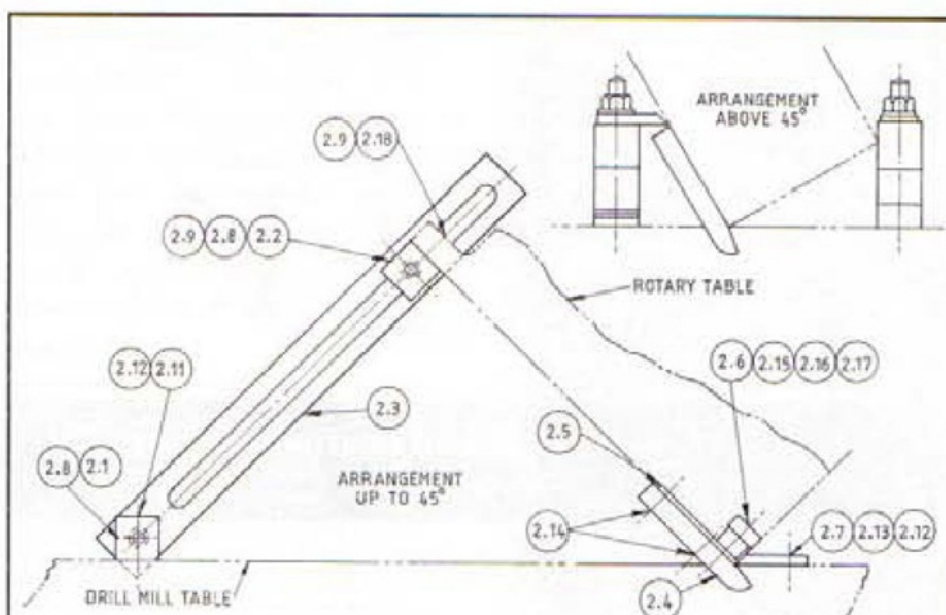


FIG. 2 ANGULATOR — ASSEMBLY

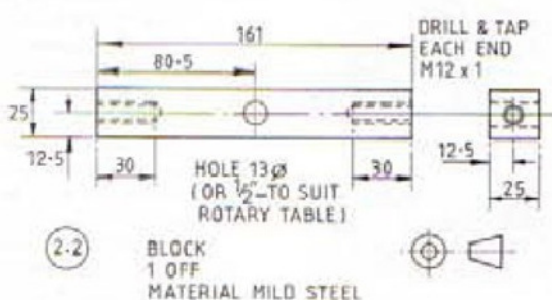
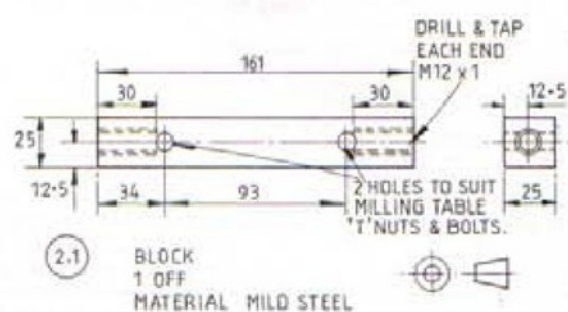
hexagonal work it is often more convenient to use a 3 jaw chuck; so one of Chinese manufacture was obtained and a suitable backplate with a 3MT shank produced to mount it. The shank was turned 3MT and again by trial in the rotary table, the required length was obtained so that a step in diameter would position the chuck backplate fixing screws to clear the rotary table face. The step was then machined and threaded $\frac{1}{2}$ in. BSPF and the backplate itself drilled, tapped and mounted on the shank, being bonded in place. The combination was then inserted in the lathe $4\frac{1}{2}$ to 3MT bush in the headstock mandrel, and the backplate was faced and stepped to fit the recessed rear of the chuck. This backplate and shank use the same M10 screw and recessed stepped bush for secure attachment to the rotary

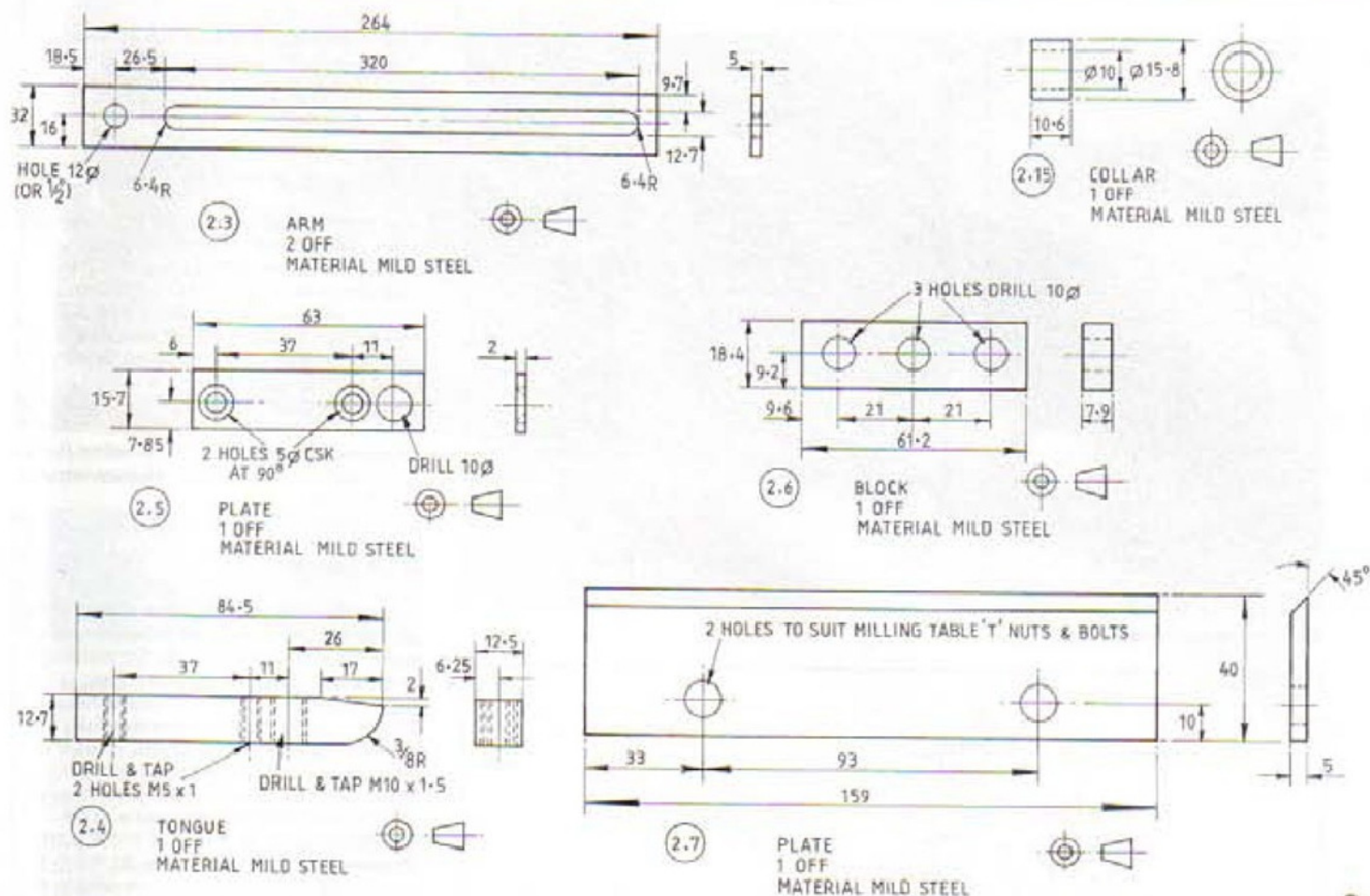


Front view of table on angle supports.



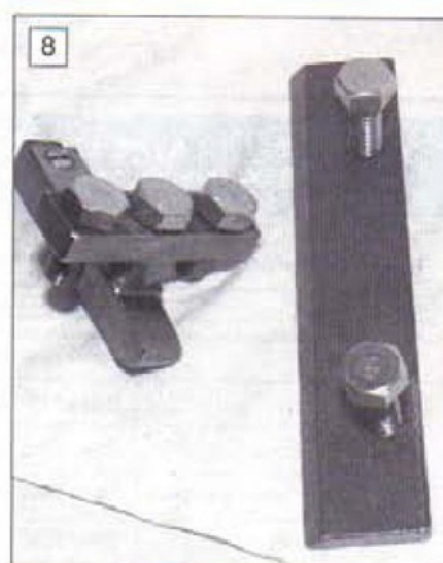
Base stop in position.





ANGULATOR - Material List (Note: BSW threads as used in prototype shown in parenthesis)

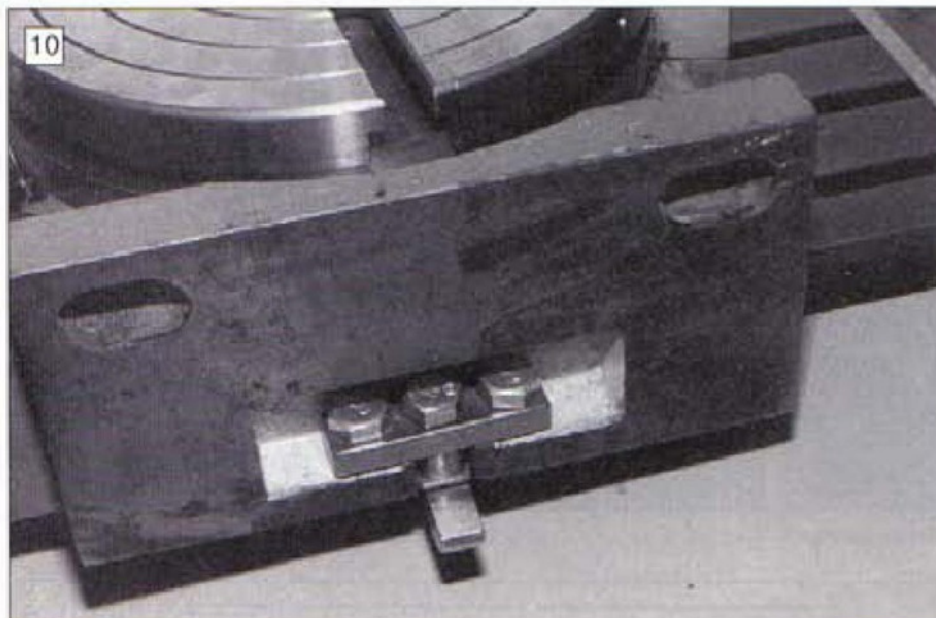
Item	Description	Material	Qty
2.1	Block	Mild Steel 25 x 25 x 161	1
2.2	Block	Mild Steel 25 x 25 x 161	1
2.3	Arm	Black Mild Steel 32 x 5 x 320	2
2.4	Tongue	Mild Steel 12.7 x 12.7 x 85	1
2.5	Plate	Mild Steel 16 x 2 x 63	1
2.6	Block	Mild Steel 20 x 8 x 62	1
2.7	Plate	Mild Steel 40 x 5 x 160	1
2.8	Screw Hex. Head	Steel Zinc plated M12 x 1 x 25 long ($\frac{1}{2}$ in. BSW)	4
2.9	Washer	Steel Zinc plated 12 mm (or $\frac{1}{2}$ in.)	3
2.11	Bolt Hex. Head	Steel Zinc plated $\frac{3}{8}$ in. BSW x 44 long	2
2.12	T Nut	Steel $\frac{3}{8}$ in. BSW	4
2.13	Screw Socket Head	Steel Zinc plated $\frac{3}{8}$ in. BSW x 23 long	2
2.14	Screw Csk. Head	Steel Zinc plated M5 x 1 x 12 long ($\frac{3}{8}$ in. BSW)	2
2.15	Collar	Mild Steel 16 dia. x 11 long	1
2.16	Screw Hex. Head	Steel Zinc plated M10 x 1.5 x 35 long ($\frac{3}{8}$ in. BSW)	1
2.17	Screw Hex. Head	Steel Zinc Plated M10 x 1.5 x 22 long ($\frac{3}{8}$ in. BSW)	2
2.18	Screw Hex. Head	Steel Zinc plated (size to suit rotary table)	1



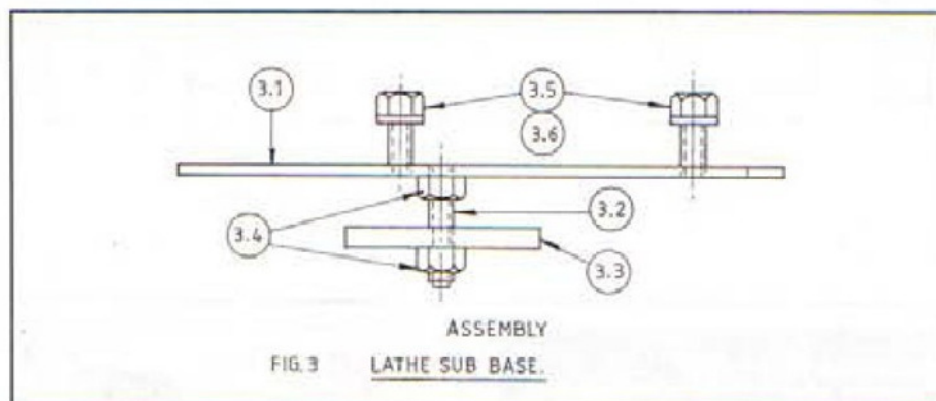
Base stop components.



Base stop from below.



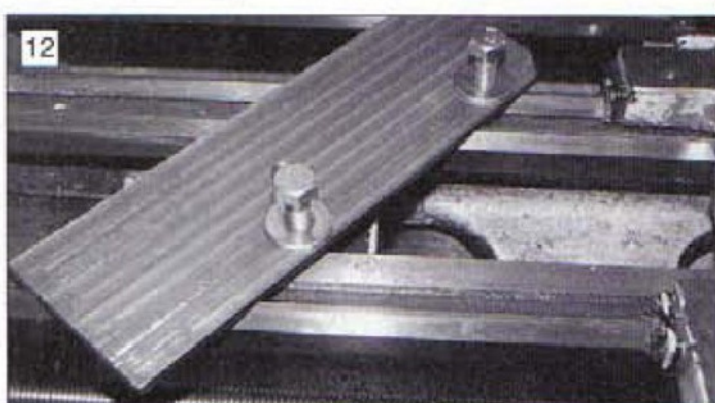
Base stop from above.



LATHE SUB-BASE Materials List (Note: BSW threads as used in prototype shown in parenthesis)			
Item	Description	Material	Qty.
3.1	Plate	Black Mild Steel 12 1/2 in. x 4 in. x 1/2 in.	1
3.2	Stud	Steel Zinc plated M12 x 1 x 63 long (1/2 in. BSW)	1
3.3	Clamp	Black Mild Steel 4 in x 3 1/2 in. x 3/4 in.	1
3.4	Nut Hex.	Steel Zinc plated M12 x 1 (1/2 in. BSW)	2
3.5	Setscrew Hex Head	Steel Zinc plated M12 x 1 x 30 long (1/2 in. BSW)	2
3.6	Washer	Steel Zinc plated 1/2 in.	2



Lathe sub-base.



Sub-base mounted on lathe bed.

table (Photos 3 & 4 and Fig.1). The chuck key shaft has had to be lengthened so it can turn without fouling the rotary table face. (Photo 4)

4. Working at angles

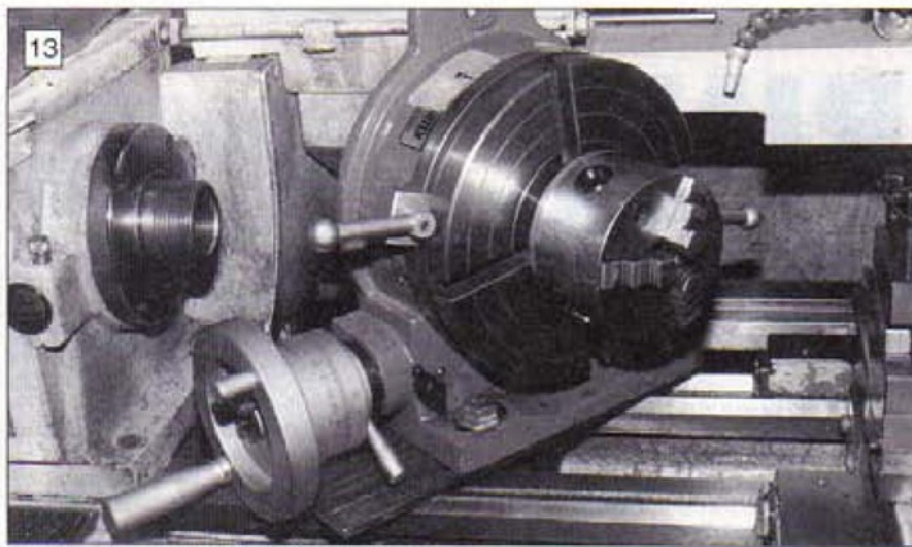
In order to cope with work at an angle other than the horizontal or vertical, arrangements were made to stand the rotary table on its rear base edge with appropriate supports. (Photos 5, 6 & 7 and Fig.2). A stop prevents movement of the edge and slotted arms allow fixing of the table at whatever angle is desired. (Photos 8, 9 & 10). There is a slight difference in the base stop arrangement, depending on whether the rotary table is angled up to 45 degrees or beyond that.

5. Use on lathe

My lathe has a Norton type screwcutting gearbox and has very few separate change gears, thus limiting their use for dividing purposes. It was, therefore, a happy coincidence to find that the centre height of the rotary table was 6.15mm less than that from the lathe bed to its centre. Thus it was possible to make a sub-base, machined from 1/4 in. steel plate, allowing the rotary table to stand on the lathe bed and be clamped in place with a stud, nut & plate (Photos 11, 12 & 13 and Fig.3). It can be positioned so that its table is parallel to the lathe faceplate or angled at up to about 45 degrees to this. Dividing for cylindrical or conical work is thus facilitated. The spanner in the photo has been cut down in length for easy use in between the lathe shears on the clamping nut. Note also the lathe chuck is removed for extra axial space.

6. Material handling

The drill/mill stands on a home made solid timber framework, having two shelves on which its accessories reside. The rotary table lives on the bottom one near the floor, and lifting its 30 kg into place presents a worry for an elderly back. A flat timber tray with a couple of dowels to engage the rotary table hold down bolt holes, a slot to accommodate the handwheel rim, and a raised piece to pull on, allows the rotary table to be easily slid forward off the shelf on to a similar height wood block. The underside of the tray is

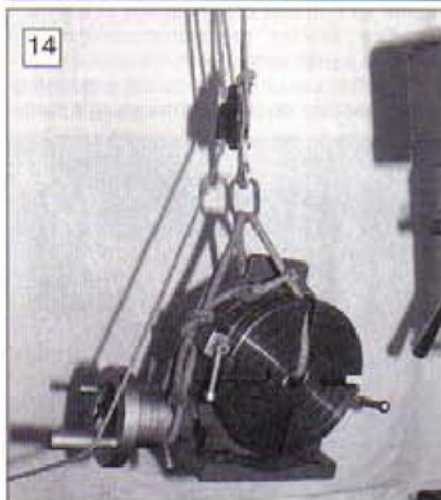


Rotary table mounted on lathe at an angle to lathe mandrel.

TROLLEY, TRACK & BRACKETS

Key to Figure 4

Item	Description
4.1	Bracket
4.2	Screw Mush. Head
4.3	Lock washer
4.4	Plate
4.5	Channel
4.6	Split Pin
4.7	Washer
4.8	Roller
4.9	Body
4.10	Bolt
4.11	Spacer Tube
4.12	Lock washer
4.13	Nut
4.14	Bolt
4.15	Washer
4.16	Nut



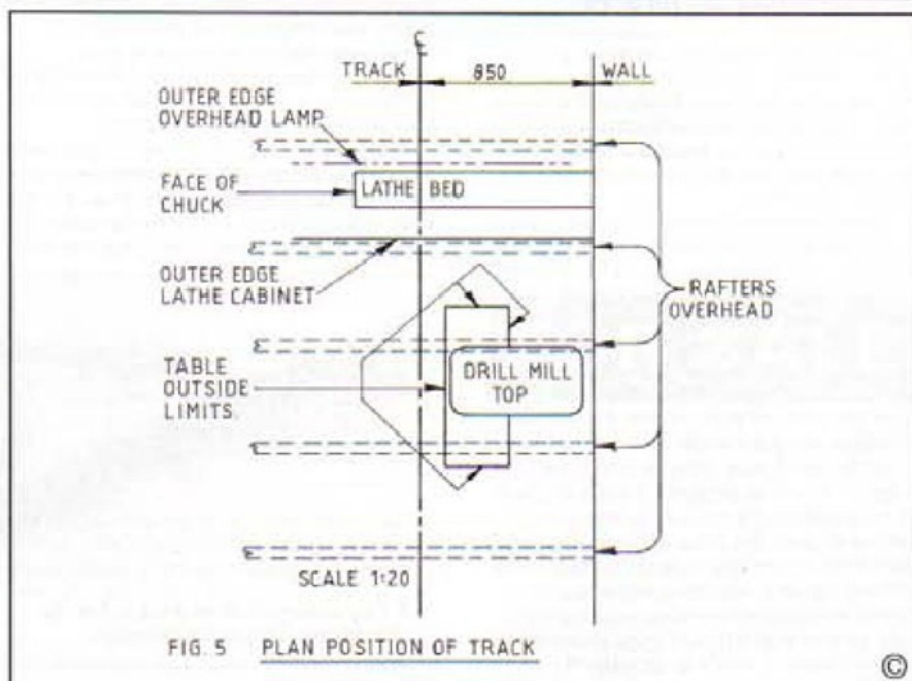
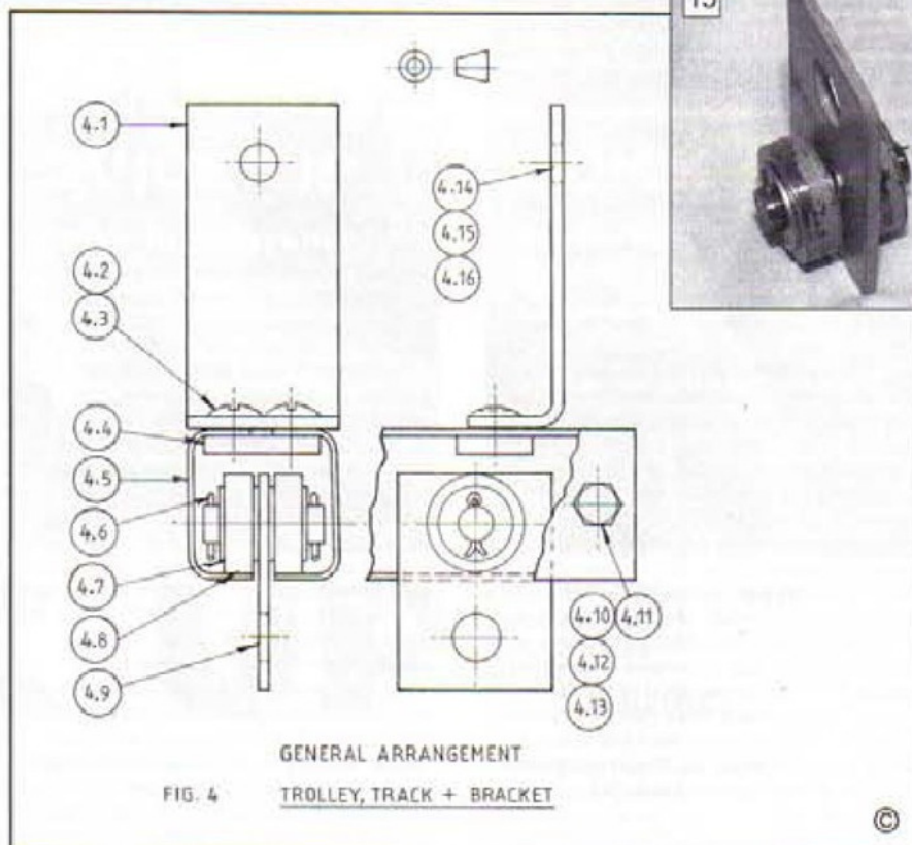
Rotary table on lifting tackle.

waxed to facilitate this. A 3 : 1 block and tackle was reclaimed from old yachting equipment and a runway fabricated from two rolled steel channels and attached to the rafters. A trolley (Photo 14 and Figs 4 & 5) running in these channels allows the rotary table to be easily manoeuvred on to the drill/mill table or the lathe bed (Photo 15)

(Note: No dimensions are given for the Trolley, Track or Brackets as these will need to be designed to suit the installation and the loads to be imposed.)



Runway trolley for hoist.



SOLDERING ALUMINIUM

Gordon Read questions a long standing myth and finds that the solution appears to have been around for almost as long as the problem.

Soldering aluminium is something which modern workshop folklore holds to be impossible, in the same category as giving yourself a haircut! It isn't impossible. The ways and means have been around for almost a century, but for some strange reason have never become widely known. Time to remedy that, because it's a very useful thing to have up your sleeve.

Two methods exist, as with most soldering. The first is ordinary soft solder. The second is hard soldering. The usual hard soldering is of course the familiar silver solder. For aluminium, the stuff to use is different, largely composed of zinc. It's easily available, about the same price per joint as silver solder, and doesn't even need any flux. Restorers of veteran and vintage vehicles have used it for years. The U.K. firm concerned, Techno-Weld were at the recent M.E. Exhibition.

The earliest mention of the stuff I've come across is in M.E. for 1 November, 1902. They picked up an article in the publication *American Machinist* about it. The rods at that time were mainly tin instead of zinc, but otherwise all seemed as today. Personal experience of the stuff makes it a standard stock item in my shop. After trying it, you may well feel the same. Anyhow, put it aside for the moment while we concentrate on soft soldering.

Soft soldering can be done!

While soft solder isn't the strongest of joint materials, it has a lot of uses, such as ensuring a sheet metal fabrication is liquid-tight. And, where applied forces are small, it's a perfectly good structural joint material. But, how to make it stick to aluminium alloy?

Aluminium oxidises very rapidly, which is the thing to overcome. It's not easy, but can often be done if you really have to. Try this as a test. Get a couple of bits of thin aluminium alloy sheet, say about 1/32 in. thick and about the size of a matchbox side. Clean a stripe down the centre of one with a scraper or whatever, and coat it with light machine oil such as 3-in-1 or sewing-machine oil: put it aside.

In the same way, clean a strip down one edge of the other bit (both surfaces). Now, get a good electric soldering iron going (about 45 watt size). Have a reel of Multicore solder ready, and tin the cleaned stripes just as if you were working on brass, except that you keep rubbing the iron up and down the cleaned bit until the tinning takes. It needs quite a bit of rubbing, and some oils seem to work

better than others.

All that done, clean off the oil residue with a tissue or the like. Hold the two bits together as per **Fig. 1**, and sweat them together. Result; a joint which holds even if not perfect. Any of the standard soft-solder types of joint can be used, but the fact is that as a technique it's more of a party piece than a useful method. The preferred way is hard soldering.

Hard soldering (welding?)

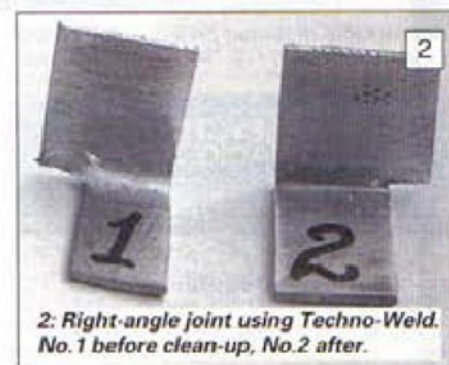
The American makers of the rod material call the process welding, but that is one for academics to argue over. The heat involved (370 deg. F) doesn't melt the parent metal, which is one definition of welding. To me, the process is nearer to silver soldering, but (as said before) the academics can argue that: high-sounding arguments. Maybe the loco fraternity don't have much aluminium in their products, but isn't it just possible that this might be a way to welded track, just like full-size? After all, a lot of folk run on alloy track! Seriously, though, it is well worth getting a trial pack of these rods just to find out what the car restorers have known for a long time!

No flux is needed, but a couple of little tools are essential. Both come with boxes of rods sold by Techno-Weld. The first is a stainless-steel scratch brush, and the second is a bit of stainless rod to, on occasions, push the molten rod material around. A bottle gas torch is fine as the heat source. The normal plumbers size covers most jobs, while one of those tiny ones would do for watchmakers jobs. The heat required is below the melting point of aluminium, but it is very easy to melt the parent metal on a small job. The snag for the inexperienced is that aluminium doesn't get red-hot or give any other warning before it starts to sag! Rather like not blowing holes in thin sheet steel with a MIG welder; a matter for practice.

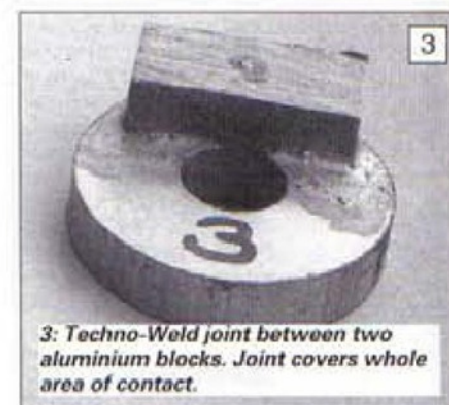
Suppose we start, as a practice job, with a couple of pieces of sheet about palm of the hand size and between 1/8 in. and 1/4 in. thick (1.5 to 3 mm if you're really that metric!). We are going to join them to form



1: Joint in aluminium using ordinary multi-core solder



2: Right-angle joint using Techno-Weld. No. 1 before clean-up, No. 2 after.



3: Techno-Weld joint between two aluminium blocks. Joint covers whole area of contact.

an angle piece as per **Fig. 2**. First, set up some kind of hearth. I use a firebrick for a coal-fire grate; a nice flat surface of firebrick I can buy any time at the village ironmonger's shop. Having done that, scratch-brush the areas to be tinned, and don't touch them again with the fingers. Put them on the hearth some little distance apart, so that you only heat one at a time. That's a "first try" precaution, you'll not need as experience grows.

With the torch in one hand and a rod in the other, heat the job and keep touching it from



4: Fabrication of three alloy tubes. 5p coin shown for size comparison.

time to time with the end of the rod. When the rod melts nicely into the surface when the flame isn't on it, that is the required temperature. Tin the surface, and use the stainless wire to spread the melt over any areas unwilling to cover by itself. If you heat too much, and the metal melts, resultant words are on your own shoulders; I did warn you that practice makes perfect!

Treat the second piece in the same way, and let both cool. Having done so, jig them up so as to be in their joined position, and heat up again. As the tinning melts, run the stainless rod along the joint to make a fillet: add more rod if needed. When cool, the bits of aluminium are joined just as would be two bits of silver-soldered steel.

That is the heart of the matter, and after a bit of practice you'll find all sorts of uses for the technique. The i.c. engine folk can now fabricate things which otherwise would have needed castings. Space-frames can be made

from aluminium alloy tubing. Fabrications of aluminium sheet with invisible joints can be made, and so on. The photos show the sort of things possible.

The car restoration trade has long known that this stuff is ideal for repairing alloy castings. Clean up the break, jig up the bits, and the rod material makes a good joint and is also reasonably gap-filling. What is also done is to use it for restoring broken off lugs and such on the edges of castings. A little mould of Pyruma fire-cement is made at the appropriate place, and rod metal is run into it. The resultant blob is then dressed or machined to match what was missing. That technique can be used to make really tiny castings with the rod material. And, as a repair material it works just as well on Zinc-alloy (Mazak) castings.

The deposited metal is about as hard as BMS, and doesn't seem to stick to tool cutting edges like aluminium. I find it machines well, and can be tapped easily. Colour, where that

matters, is so like aluminium that a dressed-down joint is nearly invisible on bare metal. Paint adhesion is something I can't comment on because I have not as yet tried, but as modern paints don't present any serious problems on aluminium, I don't imagine this stuff will be any worse.

On costs, the price seems to work out about the same per joint as silver solder. Just like silver solder, you use more than is necessary at first; but that is just part of the learning process. These rods have a definite place in a model engineering workshop, especially where i.c. engines get made.



Supplier

Techno-Weld Ltd can be contacted at Aston Works, Back Lane, Aston, Oxon. OX18 2BX.

QUICK TIP

Wetting agent for flux.

When using borax, or silver-soldering flux powder, add a single drop of washing-up liquid. This will ensure that the mixture wets the metal properly without overrun

J.W.Frazer

QUICK TIP

Lathe tool packing

If looking for packing for your lathe tools, strip down a redundant car ignition coil. You will find a quantity of straight shims about 0.02in. to 0.03in. thick dependent upon the manufacturer. Take care not to spill the oil within the unit.

Dennis Knight

QUICK TIP

Protecting leadscrews

A spiral plastic garden plant stem protector makes a good telescopic guard for lead and feed shafts of a lathe.

Hugh McNair

LINK UP

WANTED

• I would like to purchase or borrow for photocopying a users manual for Myford ML4 Lathe. R.W.Collins 72 Fernhurst Road, Doncaster. DN2 5QQ. Tel. 01 302 368782

• Any information please on Smart & Brown Model 'M' lathe. I have recently obtained one which needs a little attention and adjustment, so a manual or spares list and source of spare parts would be of great help. Bryan Rogers, South View, Bakers Lane, Felsted, Dunmow, Essex. CM6 3LP Tel. 01 371 820301

• I need a handbook, maintenance manual, accessories, lists etc. for Harrison L5 lathe (1949). Costs reimbursed.. B. Ellis Ivy Cottage, Grove Park, Hampton-on-the-Hill, Warwick, CV35 8RF. Tel. 01 926 490767

• I am looking for a headstock and mandrel, also the set of eleven change wheels for a 4in. Drummond Round Bed lathe. Mr. N. S. Ritson, 80 Biddick Lane,

Fatfield, Washington, Tyne & Wear. NE38 8AA Tel. 01 914 162509

• Information, Users Handbook etc. regarding 10mm Lorch lathe, Model LLV (1960). Any expenses willingly reimbursed. M J O'Brien Tel. 081 319 2013

• Wanted for my Tom Senior Milling machine, model M3, a No.3 Morse Taper spindle, with or without spacers, also spindle support for the horizontal spindle. I have a spare International spindle. Tel. 01 482 841929

Could anyone please tell me where I can obtain high power magnets or the material for making ceramic magnets? S J Rainbird Matapan, Brackendene, Ash, Aldershot, Hants. GU12 6BN

I am beginning the restoration of a musical box and the first job will be to 're-pin' the drum, which is brass, 2.125in. dia. x 13in. long and plays 12 tunes. Unfortunately it is parted along the original joining line and will need to be re-soldered or brazed. I have already dissolved out the old and

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- AND IT IS ALL FREE

broken pins, but now need to find a supply of wire which would be suitable for the task of 're-pinning'. Also, if any readers have successfully undertaken this laborious job, their comments would be much appreciated.

If anyone can help I would be pleased to refund any postage or charges. Alan J. McArdle 88 Trajan Walk, Heddon on the Wall, Newcastle upon Tyne NE15 0BL

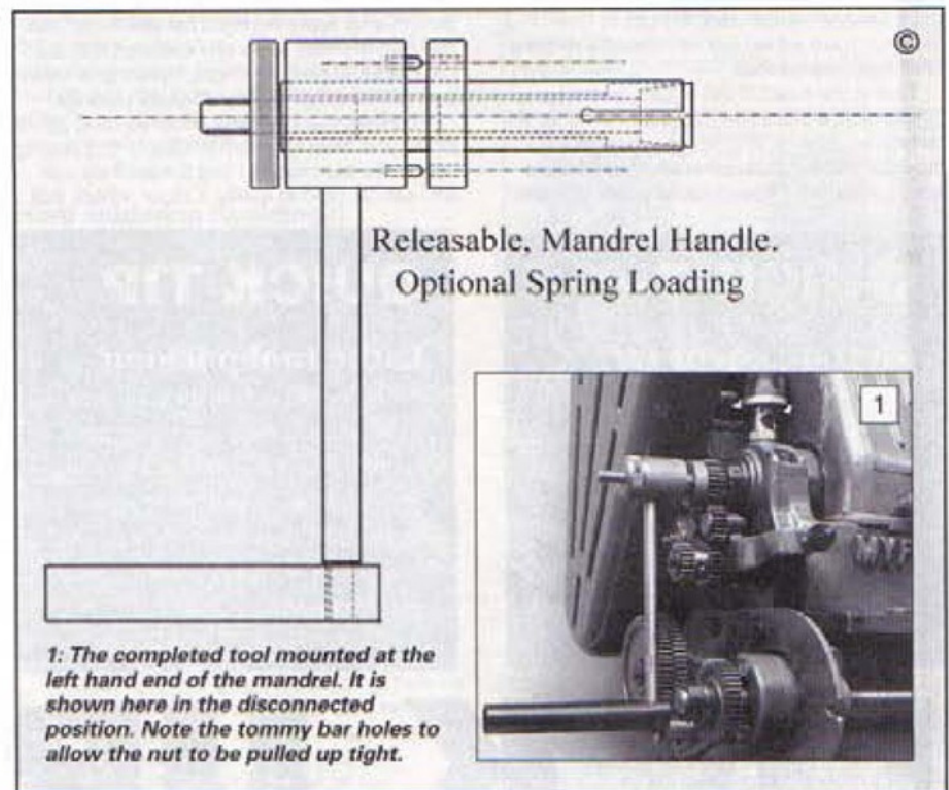
FOR SALE

• 1 H.P. Electric Motor. Single Phase. Feet & Flange. Cont. Rated £48.00. (Blackpool) 0253 354478.

• Flanged boiler material including faced and marked out barrel, complete except for tubes and foundation ring for 1 in. scale Minnie. traction engine. £35.00 Tel. 01 977 519906

A RELEASABLE MANDREL HANDLE

Stan Bray,
Founding Editor of M.E.W.
provides this article which
we are sure will appeal to
many readers

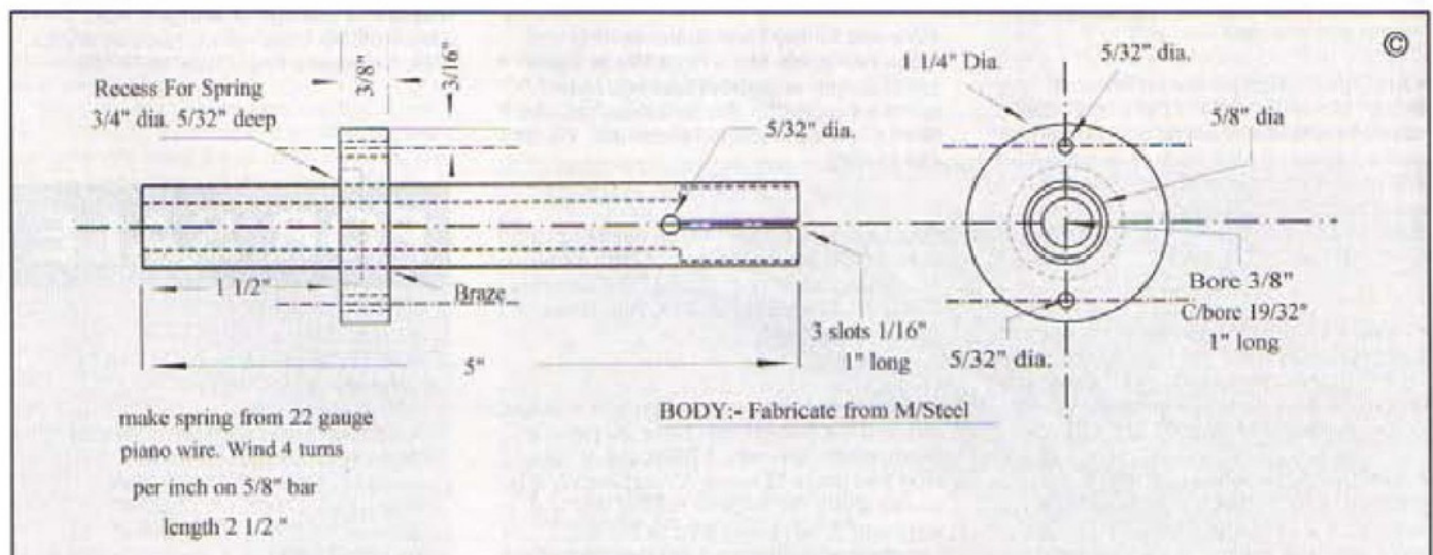


A handle fitted to the mandrel of a lathe is a very useful accessory. In fact a number of manufacturers now make them as accessories. They can be used for many purposes but in general have one big disadvantage. The lathe cannot be run with the handle in position because things become so out of balance that if the lathe is started up it feels as though W.W.3. has broken out.

One way round the problem is to make a device with two handles opposite each other, one counterbalancing the other should the need arise to use the lathe under power with the handle in position. Even this is not very satisfactory as it is difficult to get both sides balanced exactly; and anyway the fact that such a projection is revolving over such a wide arc is undesirable on safety grounds if for no

other reason. The device shown in the drawings obviates these problems and yet allows the handle to be left in position with the machine running if one wishes to adopt this course of action.

It is not proposed to go into the construction in any great detail; it is all pretty straightforward. The body is a piece of bar, slit to allow it to expand. Brazed to it is a larger piece that acts as one half of a



QUICK TIP

Marking through holes

If needing to mark through a hole, instead of using a scribe, saw the thread off a bolt which is the same size as the hole. Usually there will be a tag of metal left on the sawn end of the plain portion. Put this through the hole and turn - there should be a nice circle.

A. Baker

QUICK TIP

To test a set square.

Use a piece of material with one straight edge at least twice as long as the stock of the square. Using the square, scribe a line across the sheet. Reverse the square and scribe a second line on top of the first. If the lines diverge, the square is in error by half the angle of the divergence.

Joe Ginn

dog clutch. There is of course a hole right through to allow a draw bar to be pushed through. The other half of the dog clutch slides up and down and a light spring is fitted to make the pieces part naturally. This is not a necessity; the spring can be left out if required, in which case the clutch will have to be pulled apart by hand. If it is to be fitted both the above parts have to be recessed to allow them to be pushed together. Two pieces of round bar fitting into holes create the drive. Both the sliding section and the holes for the clutch pins should be very slightly oversize to prevent them sticking during operations.

The handle is fitted to the sliding part of the clutch. The method used was simply to screw in a piece of bar and screw another piece at 90 deg. to act as a handle. Anyone wishing to do so could make the handle rotate quite easily by drilling it through and fitting a long bolt. The one shown has a piece of plastic conduit slipped on it. This not only covers the rough old piece of metal that was used but also is warmer to the touch. It has no other practical purpose.

The draw bar is simply a piece of bar threaded at each end and the expansion nut is again a piece of threaded bar machined to a slight angle. That really is all there is to it. Many people will find they can make it from their scrap box. Even should the materials have to be bought in, they will not break the bank. In use it should be kept lubricated to prevent it from binding up, after making the tool it would be a shame if it caused an accident due to the lack of a few drops of oil.



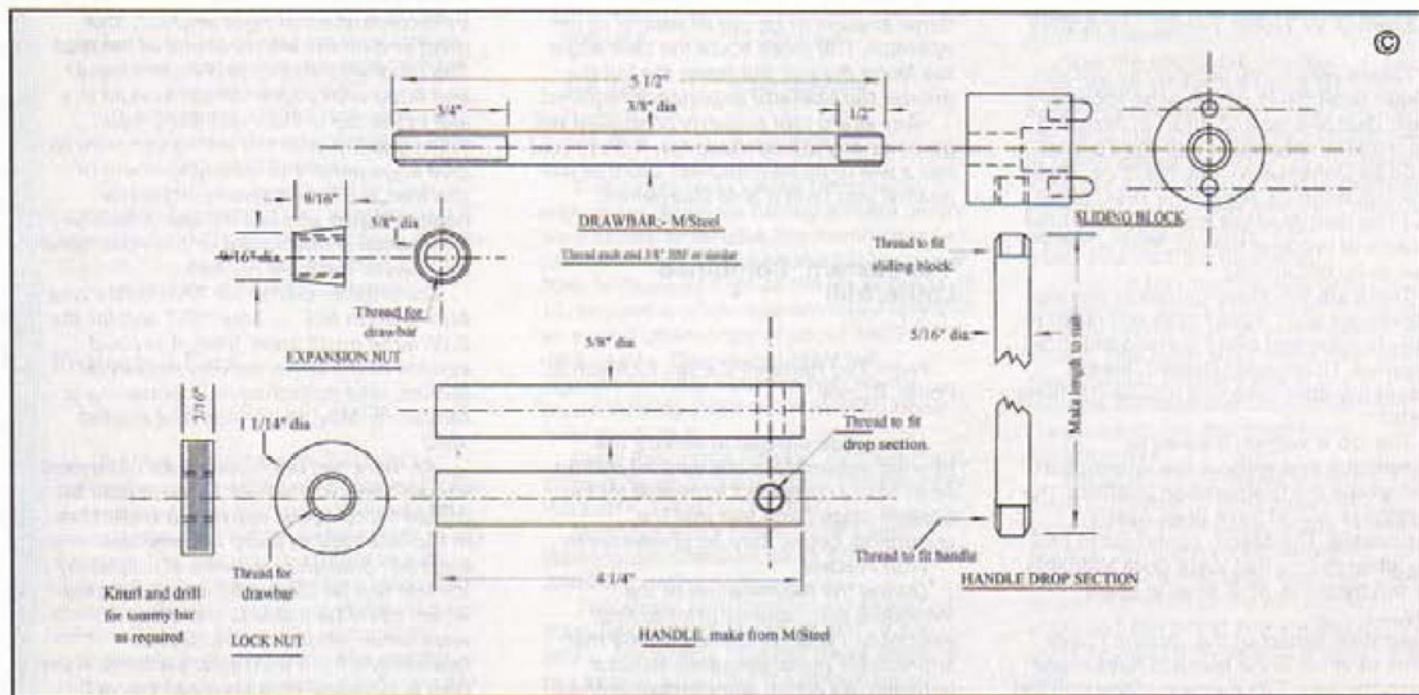
2: All the component parts of the tool, including the light spring which keeps the dog clutch out of engagement.



3: The tube which grips the mandrel seen here with the drawbar and expanding plug.

AN APOLOGY

The article on the Fretsaw Attachment for the Lathe, which appears on Page 48 of Issue 28 was incorrectly attributed to Terry Gould. The author was, in fact, Mr. R. Gauld. We offer our apologies to both these gentlemen.



SCRIBE A LINE

The Quest for Mr Morse

From Bob Loader, Harlow, Essex.

May I, through the columns of Scribe A Line, thank all those who have written to me or the magazine about the Quest for Mr. Morse.

It is pleasing that enthusiasts from places as diverse as Brest, Chorley Wood, New Jersey and Frome, at the present count, have taken the trouble to write.

My thanks especially, to those who have gone to more trouble and looked through sets of drills and catalogues, and been very free with information. From facts supplied by readers, I am now sure that the prime mover in the drill business was Stephen Morse. Whether he was responsible for the taper too, remains inconclusive, but reading from the catalogue extract kindly sent by Mr. Siebert of New Jersey, I would guess that Stephen was the chap and not Henry, although Henry must have been a prominent member of the company, judging by the list of patents in his name.

The patents marked on the drills mentioned by Mr. Haupt (I hope I have the name right) and Mr. Mackenzie must refer to those taken out by Stephen Morse in April 1863, and a later one. Perhaps, as these correspondents suggest, the dates refer to the original one and improvements to it.

Because we have a fairly easy time in choice of tools and cutters to do a job, I try to spare a thought for those, who in their time, had many fewer facilities and equipment. It must have been a quantum leap when the chaps who had to file the flutes in drills were first supplied with a machine to do it.

Sentinel Type 58 Universal Milling Machine

From D. W. Noble, Forres, Morayshire

Please would you convey my grateful thanks to all those people who took a great deal of time and effort in assisting me with the refurbishing of my Sentinel Type 58 Universal Milling Machine. (See Link Up, Issue 23, May/June 1994, page 24.) The history of the company and how it came to produce the machine is, on it's own quite fascinating.

There are too many names to mention individuals and I hope I have not failed to reply to each and every correspondence I received. To anyone I missed, please accept my apologies and forgive my filing system.

The job is well on it's way to completion and without the information and advice the brotherhood supplied, the enterprise would have been nearly impossible. The search continues to find the attachments that were once available for the machine, so if anyone spots any.....!

Another aspect of the venture I have come to value is the friends I have made along the way. The number of like minded

people around was quite a surprise. Once again, thank you all.

Drilling Brass (Scribe A Line Issue 26 Page 65)

From A. Denton, Kempston Beds.

Geof Helliwell gives a word of warning by suggesting that 'drills a bit blunt' (I suppose 'a bit sharp' means the same thing, or does it?) should be used for drilling brass. Joe Ginn is certainly more correct in stating 'always use sharp drills'. Sharpness and bluntness has nothing to offer if left unqualified.

A blunt drill will require greater pressure to start cutting and this pressure must be maintained to continue cutting. In consequence, when the drill starts to exit the hole, it grabs the edge of the hole and draws the undrilled portion up into the flutes of the drill. This waste material forms keys that are attached to the job being drilled, the flutes of the drill forming spiral keyways. Only one of three things can then happen:-

1. If the work is securely clamped, the drilling machine spindle will stall and in turn the drill motor will burn out if not protected.

2. If the work is securely clamped, the drill shank will turn in the chuck or the drill will break between the chuck and the work.

3. If the work is not securely fixed, the work will turn and wind to the top of the drill flutes, then spin round at the speed of the drill until arrested by stopping the machine or breaking the drill.

A sharp drill will require less pressure to cut the material and therefore is more easily controlled, but if the pressure is not eased off prior to exiting the hole, the same condition will be created as in the above.

The cutting rake of the drill is reduced to a near zero angle so that the cut is not fierce enough to be out of control of the operator. The more acute the rake angle the faster the cut, the faster the cut the greater the operator experience required.

Any sharp tool properly controlled will go or do any job its made for. A blunt tool has a will of its own and will use that will against you until it is re-sharpened.

'Far Eastern' Combined Lathe/Mill

From Ted Hartwell C.Eng., F.I.Mech.E., Poole, Dorset.

I have recently had to service the bearing assembly of the vertical milling head of my combined lathe/mill (of Far Eastern origin) and feel that the comments below may be of interest to your readers.

During the examination of the individual components prior to final assembly, I was concerned to find that appreciable radial clearance existed between the actual spindle diameter and

the bore of the quill. While the access slot for drifting out Morse taper drills or cutters is partially shrouded by the head casting, the opportunity occurs in certain instances for foreign matter, particularly swarf, to enter this slot where it can fall directly into the lower taper roller bearing. Due to the time element, the unit was re-assembled without modification but it is intended, at a later date, to fit an upturned cup in the bore of the quill having, say, five thou clearance on the spindle diameter. No facility for lubrication seems necessary with the taper roller race lightly packed with soft grease.

In all other respects the machine is very well made, the opposed taper roller races providing more than adequate support for the milling spindle.

I would add that the above comments apply to a machine some five or six years old and not of the same detail as that currently being advertised by Chester UK Limited, whose product, I understand, is built to their own specification.

Martin Cleeve Toolholders and E.W. Lathe Modifications

From Ian Dawson, St. Leonards-on-Sea, Sussex

Re Mr. Lacy's query in M.E.W. No. 26, this particular version of the Swing Clear Tool Holder was never described in Model Engineer.

It was a development of Martin Cleeve's earlier and more basic design for 3/4in. lathes - and also for the E.W. 2 1/2in. lathe - and was patented before being marketed by Thorcraft Ltd in Hastings.

The original, more basic design relied on Martin Cleeve's favourite method of manufacture - pieces of mild steel carved to size and bolted together with socket head capscrews. The toolholder was bolted to swing arms so that the slot was parallel to the pivot. In the version that was put on sale, the tool holder and swing arms were, I believe, carved from one piece which enabled a second tool slot to be incorporated, at right angles to the pivot and on the left hand end of the tool. The pivot was also turned eccentrically and fitted with a lever which worked in a slot in the top of the main body, used when a tool was in the left hand holder to give engagement or disengagement of this tool, e.g. when screwcutting (in reverse it also allowed the same facility for internal screwcutting or boring when a tool was in the front holder).

The original design for 3/4in lathes was published in M.E. in May 1957 and for the E.W. lathe on 19 June 1960. A revised version of the larger holder, heavier in section, was published in Engineering in Miniature; May, June, July and August 1980.

As there has been quite a lot of interest shown lately in the E.W. Lathe, it may be of interest to newer owners to know that in the late 1950's / early 1960s Model Engineer published a series of articles by the late Martin Cleeve on improvements which could be made to the lathe. All were either simple turning jobs or fabrications from mild steel sections. A list with publication dates is given below.

There is a good reason for the 24 year gap between the dates for the Tee-Slotted Cross Slide and the Top-Slide. I believe that the Editor of M.E. in 1958 declined to publish the article on the Top-Slide on the grounds that it was an old fashioned & outdated design! Fortunately for us, his successor in 1982 thought better of it and published.

Finally, in M.E.W. No. 25, in Trade Counter you mention the K.J.C. Milling attachment for the lathe. M.E. for 2 March and 10 May 1950 contain two articles on the Target milling attachment which may be of interest. In any event, it is interesting to see that some of the old devices are still considered worth putting on the market.

E.W. Lathe Data

Headstock Mandrel Clearance Hole: $\frac{1}{2}$ in.
Headstock Mandrel Thread: 1in. x 12 TPI
Headstock/Tailstock: No. 1 Morse Taper.
Leadscrew: $\frac{1}{2}$ in. x 8 TPI Right hand thread,
Cross-slide/Top-slide calibrated: 0.001in.
(Not all models calibrated).
Cross-slide/Topslide Feed Screws: usually
 $\frac{1}{2}$ in. BSF
Top-slide Swivel calibrated: 5 degrees.
Headstock Pulleys: accept $\frac{1}{2}$ in. Round belt
or 'M' section Vee belts.
Screw Cutting Attachment: 10 change
wheels, 20 - 65 Teeth inclusive.
Threads: 10, 12, 14, 16, 18, 20, 22, 24, 26,
32 & 40 TPI

Martin Cleeve improvements detailed in M.E.

Introduction 20/6/57
Tee-slot Cross-slide 8 & 22/5/58.
Top-slide to match above 19/2, 16/4, &
1 21/5/82.
Rack feed tailstock 6 & 29/10/60.
Leadscrew clutch 10/10/57.
Improved leadscrew nut fixing 29/8/57.
4 Tool front toolpost & 2 Tool rear toolpost
24/7/58.
Swing clear boring/screwcutting tool
holder 19/6/60.
Fixed steady 20/1/58.
Adjustable saddle deadstop 25/7/57
Replacement headstock spindle with
patent chuck fixing 30/6, 14/7 & 28/7/60.
Tee slotted faceplate for above 8/9/60
Fine feed gearbox 19/12/57 & 9/1/58
(includes tables of screwcutting trains).
Cross-slide and leadscrew replacement
ball handles 3/10/57.
Lathe stand 11/7/57 (includes
arrangements for wider variation in
mandrel speeds).
Chucks $\frac{3}{4}$ in. Lever scroll or Geared
scroll Self Centring, $\frac{3}{4}$ in. Independent 4
Jaw. $\frac{1}{2}$ in. Drill Chuck. 8mm or $\frac{1}{2}$ in. Collets
up to $\frac{1}{2}$ in capacity can be fitted, using
adapter in headstock taper.

Protected Ears.....

From J.L.West, Gosport, Hants

I feel I must reply to Pam White's article (November/December issue) on Ear Defenders. I now find myself in the same situation as Pam White with regards to my hearing. The loss has been due to a 25 odd year marine engineering career with the Royal Navy. I can sympathise with her on the Tinnitus issue. I get a constant whistling in both ears (akin to a boiling kettle) and a gooey smelly discharge. My

wife (and the rest of the family) complain about me having to turn up the TV, radio in the car, not hearing the phone ring and having to shout to get my attention. During my career I made sure my ears were protected. The machinery I worked with ranged through high pressure marine boilers, turbines, steam generator sets and all the associated auxiliary machinery, Gas turbines and diesel engines (including the good old Deltic). Two 18 7A Deltics running flat out for a week at 1478 revs scream quite a bit. Working in that environment for 18/20 hours a day, especially during a break down on a small mine sweeper, it was difficult to get away from the noise completely.

With all the above machinery I have mentioned, and the remaining I have not listed, plus environmental temperatures some times up as high as 130 deg F, my hearing took a hammering, even wearing ear defenders.

By engulfing the ear with ear defenders for long periods of time, could this still cause damage? Sweat and condensation builds up inside the ear defender. Would this cause excess moisture on the ear drum? Could high pitched sound waves penetrate the skull still reaching the inner ear? Perhaps some of our more learned readers could shed some light on this particular part of the problem.

I also ride a motorbike and find that I have to wear ear plugs. Have you thought about that half open car window during the summer? A nice breeze, but what about the noise (especially on a long journey)? I have contacted Racal at Bognor Regis in West Sussex for some info; this is the result of my enquiry.

Decibels	Working Period (Max.)
90 dBA	8 Hours
93 dBA	4 Hours
96 dBA	2 Hours
99 dBA	1 Hour
102 dBA	30 Minutes
105 dBA	15 Minutes
108 dBA	7 1/2 Minutes
111 dBA	3 Minutes

This safety level varies world-wide, with some countries having a noise safety level as low as 80 dBA. The human ear can identify sound from frequencies as low as 20Hz to those as high as 20kHz, (a range of 10 octaves) and can tolerate noise levels in an even higher range of about 140/180 dBA (ouch). The decibel scale is a logarithmic ratio between two sound levels. Adding 3dBA to an existing noise level doubles it.

Racal Panorama Limited, Christie Place, Durban Road, Bognor Regis, West Sussex. PO22 9RT. Tel. 01 243 828911.

Northern Sales Office, Folly Lane, Warrington, Cheshire, WA5 5NY. Tel 0925 234656.

The above information was extracted from Racal's own literature and I thank Mrs L. Mackenzie (Bognor Regis office) for her help in supplying the information. I

would also like to thank Mr P Rabin of their Head Office at Wembley for casting the all knowing eye over this letter and offering his own professional advice.

My hearing loss? Well, I will have to put up with it, and all at the tender age of 44 (sorry love, did you say something?).

.....And Clean Hands

From A Denton, Kempston, Beds.

Having dozed off in my favourite chair with Issue 26 of Model Engineers' Workshop on my lap, I awoke and continued to read Scribe a Line, item headed Ear Defenders on page 65. I thought my wife was playing a joke on me and had swapped my magazine for her women's magazine. I turned to the front cover and found, no she was not playing a joke on me, it was actually a letter in your magazine from Pam White.

My wife has suffered with Tinnitus since the age of seventeen, some fifty five years or so. There is no cure for this complaint. Noise may be a contributory factor to the cause but not the cause. If as is suggested by Pam we wear ear defenders in the workshop, how would we cope with not being able to hear the noises that warn us, when an electric motor is labouring, a cutting tool or a drill bit needs attention or a pleasant 'ting' when the scriber point tells us that the job is not running true in the four jaw or worse still when the wife shouts from the back door "Tea up".

Enough of the Medicals, let's get down to the Cosmetics. My mother could not afford olive oil and sugar as a hand cleaner, it had to be sand and cold water, but we have moved on many years since those days. Perhaps someone should tell Pam about skin Barrier Creams for working in wet or dry conditions and the subsequent washing off with warm or cold water after using a suitable Hand Cleaner gel; both items contain an antiseptic solution. Of course I could write a whole page of the different types of protective gloves that are available, some of them costing less per pair than the proverbial pound of sugar.

Now the meaty bit. The free advertising, or are the Boots worn as Safeways of applying the Fairy Liquid to the parts that other cleaners cannot reach (if I send a copy of this to 'H.....' will they send me a rake of their freebie goodies?). Pam says "Do not use any sort of washing powder or liquid". Why? Pam, many of these powders are pure soap.

There is too much plugging in the magazine of everyday products that can be obtained in High Street or Corner Shop stores. This letter is a blatant example of this practice. Perhaps this is one of the reasons we have lost the Oil Stores, Hardware shops and traditional Ironmongers.

Perhaps of no interest to others, I have been subjected to loud noises all my working life; from guns, shells, mortars, bombs, compressed air hammers, panel beating, demolition etc., and I am pleased to say that my hearing has not been impaired, the worst and loudest noises are dogs yapping and barking through the day.

As you can see I am not dissatisfied with Model Engineers Workshop Magazine in fact I have recently sent for a further two year subscription.

A Vice from the Past?

From Gerry Ward, Morinville, Alberta, Canada.

Seldom is this reader moved to apply pen to paper, but in the light of recent press releases, is prompted to do so.

Recent copies of both Model Engineer and Model Engineers' Workshop carry notices that the Record Tool Co. have produced what is said to be their smallest metal working vice ever, having a jaw width of 2 1/2 in. and designated as No. '0'.

In 1940, I purchased, from a hardware shop near Darlington market place, a Record vice clearly marked No. '00' and having a jaw width of 2 1/2 in., inarguably smaller than that now offered.

Was this perhaps a previous Record Tool Co., or did my little vice fall through a 'time warp' from some period still in the future?

Although I remember the cost as representing a considerable outlay to a 14 year old model engineer in the first year of his apprenticeship with the L.N.E.R. North Road Locomotive Works, it has most certainly proved to be one of life's better investments. Although it now looks almost as beat-up as its owner, it continues to serve as well as ever.

Perhaps it's worth a letter to Mr. Guinness; 'Dear Sir, I have in my possession a No. '00' vice. Is this a Record?'

Clean Data

From Robert Wragg, Maltby, S.Yorkshire.

With reference to the Workshop Data Book, it is full of useful information for day to day use, so much so that its pages are in danger of being damaged by much oiled fingers. I would therefore like to pass on an idea I have had, for use by other readers.

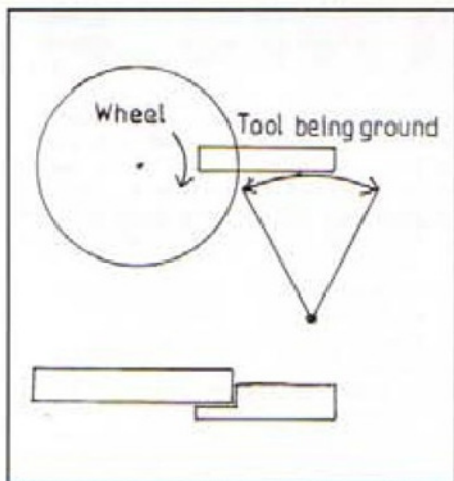
I have found that plastic A5 filing covers fit the cards perfectly and can be wiped clean of any marks or soiling. At around 14p per file, I find these to be a good investment.

Safety when Grinding

From Bob Margolis, Camberley, Surrey

I read John Scoggins' 'Sweeper' article (Issue 28) with great interest. In the search for sharp tools, I have used a motley collection of methods, freehand and others. The aim is to be able to grind tools accurately enough to finish a Quorn cutter grinder to be able to grind tools accurately....!

I would like to sound a note of caution about all such methods that do not rigidly constrain the tool being ground. The problem is the possibility of the tool wedging against the wheel. This is most likely to arise when grinding away the side



of a tool, e.g. when thinning the end of John's screwcutting tool from 6mm to 3mm.

I hope that you can see the possibility of the partially thinned tool snagging, being forced downwards into closer contact with the wheel and the situation becoming rapidly worse, possibly leading to a wheel burst.

The solution, for this aid, is to be very careful about contact pressure and the positioning of the baulk. It is still almost impossible to guard against the risk without readjusting the fixture very frequently, but an awareness of the problem may help users to avoid serious trouble.

All this raises the more general point that, in the end, a tool grinder really needs to restrain the tool in all directions except the one in which very small cuts are being taken. In the direction of feed, ideally the cut should be under mechanical control. Inevitably, one is led to tool holding arrangements equivalent to those on the Quorn, Stent, Clarkson or similar. Unfortunately, to make such a device one needs sharp tools...which is where we all came in!

How to Suppress Radio Interference?

From David Wilkinson, London

I have recently fitted a 3-phase motor to my ML7 and purchased an ABB ACS 200 frequency converter to drive it. This gives a very useful 50:1 range in speed and saves a lot of belt changing and even saves using the backgear. It is also possible to make your own control unit - I mounted a diecast box on the Myford with on-off, speed and forward/reverse controls. This is a good deal more convenient than using the front panel controls.

However, if "er indoors" or a nearby neighbour wants to listen to Radio 4 on long wave, they will find it almost inaudible due to interference. I spoke to the suppliers, who put me on to ABB(UK) who had no real answer and put me on to a firm who make interference suppressors. These cost almost as much as the converter, at which point I gave up. I have a screened cable from the unit to the motor, and have tried screening the mains cable without effect. Has any other reader had more success than I have?

Low Melting Point Alloys

From D. J. Balch, Kendal, Cumbria

In his article entitled; Gear Cutting Without Complex Cutters, Barry Holt described the use of a low-melting-point alloy for making moulded patterns.

This sounds like the alloy which we used to use in pipe bending to maintain the cross section of the pipe by avoiding collapse or wrinkling. It is poured into the pipe before bending and then melted out afterwards. The low melting point, as well as being less hazardous, avoids having to heat the pipe to a point which may transform its properties.

The alloy used to be sold under the trade names of Cerrobend and Cerrosafe if I remember correctly and was also used to make the joke teaspoons which melted in your teacup. A plumbers merchants would probably be the best place to start.

Eliminating Backlash - Safely

From Oliver Wilson, Thaxted, Essex.

I have read, so many times, the instruction 'to wrap a string round the chuck to eliminate backlash....', but never read any instruction on how to do it so that the set-up is foolproof. The photo in issue 28 page 47, photo 9 shows this system.

My method is as follows; arrange the indexing system so that the work will rotate in the usual direction, i.e. top towards you. This may mean changing a detent position so that it is in tension, or beefing it up in compression. Fix your string to the chuck, but wrap it round top away from you and after a couple of turns, lead it away from the chuck. Ideally, a small pulley should be fixed or clamped to the front of the bench and a two or three pound weight hung on the line, just clear of the floor.

The reason? - The forces all help to keep the chuck screwed on to the mandrel. Instead of trying to unscrew it! I was cutting a large wheel once and the vibration of flycutting the teeth loosened the chuck and the weight unscrewed it, undoing about an hours work in about three seconds! As you index, you lift the weight, so the load on the set-up stays constant. Revolving the work in that direction enables you to see what you have just done.

On a totally different subject, I would like to say that although I have actually made very few of the items covered in the magazine, I would have liked to if I had more time. However, I have always read every article because, even if incomprehensible (electronics!), they are full of ideas and approaches to problems, and that help solve some of mine!

The other thing I find fascinating is that things I think really good, others regard as a bodge and vice versa. For example, I would never use an electric drill in the way that is described by Mr Brooks, as I have a milling spindle and I regard the drill's bearings to be far too sloppy to be accurate, but this shows that I may be wrong, and if I did not have the spindle it would enable me to make dozens of things that were previously impossible.